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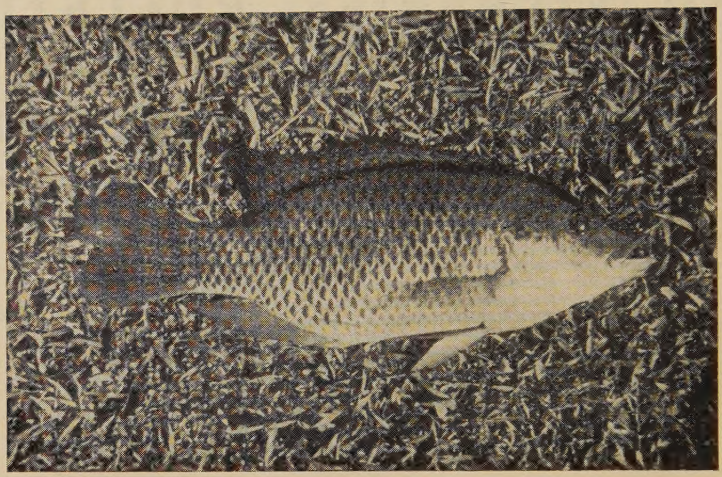

Figure 1. *Tilapia mossambica* (Peters)

Figure 2. Spawning holes for *Tilapia mossambica* in the bottom of a pond.
(Photos by courtesy of M. Huet)

THE TILAPIAS AND THEIR CULTURE[1]

A Second Review and Bibliography

Introduction

The publication in 1955 of the author's "Tilapia and its Culture, A Preliminary Bibliography" in a previous issue of the *Bulletin* (122*a*) was the first attempt on the part of the FAO Fisheries Division to review the voluminous literature on this group of useful food fishes, and to provide a convenient summary of the information abstracted from the papers listed.

Since that time many further papers have been published, and a search of the literature has unearthed others not listed in the original article. Moreover, many letters have been received referring to the article and offering further information on the tilapias[2]. Some additional information was also gathered by the author during the Third International Inland Fisheries Training Center, held at Bogor, Indonesia, at the end of 1955. In view of the widespread interest in this group of fishes it has been thought useful to publish this supplementary article to bring together this mass of new information[3].

It has been possible to complete the three tables previously published and to add a fourth in this *Bulletin* on minimum temperatures affecting tilapias. Additional information is given on all three chapters of the original article, and there is a fourth chapter, concerning barrier-lakes and artificial reservoirs that have been stocked with tilapia, using a technique which is half-way between that used for open waters and that adopted for pond culture. There is also a brief fifth chapter on the use of tilapia for other purposes[4].

---

[1] By Pierre Chimits, Ingénieur des Eaux et Forêts, Ministère de l'Agriculture, Paris, while engaged as consultant with FAO, Rome, Italy.

[2] FAO thanks all contributors for their letters and chiefly Messrs. B. Charpy, H. Copley, D. Hey, M. Huet, K. Kuronuma, G.I. Murphy, W.H. Schuster, Dr. E. Trewavas, and A. Yashouv.

[3] Several notes concerning tilapias given at the Second Symposium on African Hydrobiology and Inland Fisheries, held at Brazzaville, French Equatorial Africa, 3 to 13 July 1956, were received too late for abstracting in this article. It can only be indicated here that the Symposium emphasized the need of a taxonomic study of the genus Tilapia. An important section of the Symposium was a review of the improvements realized during the last three years in tilapia culture in Africa and the expansion of domestic pond culture.

[4] This text is a summary of information drawn from the papers listed and abstracted and from the letters mentioned.

It is to be remembered that, although in this text the formula "According to X....." has generally not been used, all statements derive from the authorities cited, and every effort has been made to avoid wording which would convey any extension of the arguments or conclusions presented in these authorities. There has been no critical review of the statements made.

TABLE 1 - PRINCIPAL SPECIES OF THE GENUS TILAPIA, CICHLID FAMILY, OF THE PERCOMORPHOUS ORDER

Species	Area of Origin	Food	Length and Weight				Culture
			Maximum		Average Table Fish		
			cm.	*g.*	*cm.*	*g.*	
* *T. galilaea*	Galilee and Jordan to Nigeria (Nile and Senegal)	Phytoplankton feeder	35	800	20	150	In ponds - Israel
* *T. nigra*	Kenya Uganda	Omnivorous (including algae and debris, but not higher aquatic vegetation)	38	1 000	20	150	In ponds - Kenya, Uganda, northern Belgian Congo.
* *T. sparmanni*	Southern Africa from Angola and Katanga						In ponds - South Africa
* *T. variabilis*	Lake Victoria	Omnivorous (including algae but not higher aquatic vegetation)	30	500	20	150	Pond tests. This species has been introduced into barrier-lakes and artificial reservoirs in British East Africa.
**T. zilli*	Lake of Galilee, Jordan, Sahara, Lower Egypt, Lakes Victoria, Rodolphe, Tchad, Nigeria, Gold Coast.	Phytophagous (including higher aquatic vegetation such as chara) same as *T. melanopleura*	35	800	20	150	*Idem*

* These species were not included in Table 1 on page 2 of the previous article in *FAO Fisheries Bulletin*, Vol. VIII, No. 1.
* The information here is to supplement or replace that given in the previous article in Vol. VIII, No. 1.

TABLE 2 - 1953 FISH YIELD FROM CERTAIN AFRICAN LAKES*

(according to information taken from the annual report of the Uganda Fisheries Service)

Lake	Total Catch per ha./per annum (*kg.*)	Catch of Tilapia per ha./per annum (*kg.*)
Albert	8.3	1.16
Edward	40.0	main catch
George	137.0	96.0
Kyoga	13.0	partially
Nakivali and Kachira	230.0 almost exclusively *T. nilotica*	introduced in 1934
Victoria (Uganda portion)	3.5	partially

* Supplementary to the data given in Table 2, *FAO Fisheries Bulletin VIII* (1) : 4.

TABLE 3 - TIME-TABLE OF THE TRAVELS OF *TILAPIA MOSSAMBICA* †

Introduced in	Coming from	Date	Manner of Introduction into Open Waters
British Guiana	Haiti	1954	
Egypt	Thailand	"	
Fiji (Polynesia)	Singapore	"	
Japan	Thailand	"	
Cook Islands	Fiji	1955	
Guam	Philippines	"	
Laos	Thailand	"	
New Caledonia	Fiji	"	
Saipan (Micronesia)	Philippines	"	
South Korea	Thailand	"	Direct release

† Additional to Table 3, *FAO Fisheries Bulletin*, VIII (1) : 8.

TABLE 4 - MINIMUM TEMPERATURES AFFECTING TILAPIAS

Species	Minimum Temperatures (°C.)	Country of Observation
T. galilaea	9°	Israel
T. macrochir	13° (killed at 12°)	Belgian Congo
T. melanopleura	13° (killed at 12°)	Belgian Congo
T. mossambica	10° (killed at 8°) (affected by prolonged exposure to 14° for some days)	South Africa
T. sparmanni	7°	South Africa
T. zilli	9°	Israel

It should be noted that a special study of a fourth species *T. nigra*, has been added to those concerning *T. mossambica, T. melanopleura* and *T. machrochir*, since definite information is now available concerning its ecology and the problems involved in its breeding.

For various reasons it appears desirable to emphasize by repetition the general thesis behind these articles. Much publicity has been given to the transplantation of *T. mossambica* and to its cultivation in various countries; unfortunately, it has been stated directly, and conveyed by implication, that this species is a wonder-fish and suitable for all situations and all purposes. It is necessary to correct this impression. *T. mossambica* has certain advantages and certain disadvantages; it is suitable for some situations, but not all, and for some purposes, but not all. Persistence of the false impression concerning *T. mossambica* is dangerous for two major reasons. Firstly, that it may lead to failure of programs of inland fisheries development; secondly, that it may cause neglect of consideration of the suitability of other species. In order to counteract the effect of unwise publicity concerning *T. mossambica*, it seemed desirable to begin by drawing attention to the fact that *T. mossambica* was only one among a relatively large number of tilapias, many of which were superior in one or more respects. The first stage of this program is the presentation, in these *Bulletin* articles, of a broad conception of information concerning the tilapias.

That tilapia is only one among many genera in the Cichlid family of fresh - water fishes, and that Cichlids are only one of many families of fresh - water fishes, are facts of which the significance must be further publicized in the future.

Culture of two other species of tilapia has also been practised on a small scale for some years: *T. galilaea* in Israel (155, 158, 172); *T. sparmanni* in South Africa (116, 137). Experiments in the culture of five other species: *T. nilotica* (98, 110, 120); *T. zilli* (105, 142); *T. variabilis* (105); *T. andersoni* (134); and *T. kafuensis* (168), have also been undertaken by research workers, principally British, Belgian and French, in various African countries, but it is too early yet to evaluate this work. It should be stressed that, because of their need for high water temperatures, tilapias, with the possible exception of *T. sparmanni*, cannot live in temperate countries. Attempts to introduce *T. melanopleura, T. nigra, T. kafuensis, T. andersoni, T. mossambica* and *T. sparmanni* were made in the southern part of South Africa (128, 137). The first four species, because of low temperatures in winter, did not survive. *T. mossambica* was badly affected and only *T. sparmanni* was able to survive at a temperature below 8° C. (137).

Tilapia culture is profitable only in hot countries and in those where there is a shortage of protein food. Tilapias for human consumption, even if small, are acceptable. Some experts consider that in tropical countries, where submerged aquatic vegetation is abun-

dant, the plant-feeding *T. melanopleura* and perhaps *T. zilli*, a species now being studied, seem to be preferable (146, 147). *T. mossambica*, which is widely distributed in tropical countries, although omnivorous, does not feed on coarse vegetation. For this reason experiments started in Thailand in 1955 are being carried out with *T. melanopleura*.

I. Tilapia in Open Waters

1. Origin

Except where introduced by man, species of tilapia are present only in Africa and in Asia Minor (18). The Cichlidae appear to have originated in South America (123) but, so far as is known, no fossil tilapia has been found outside Africa or Asia Minor, and this genus can therefore be considered as indigenous to these two areas (18). Fossil tilapia, closely related to *T. mossambica*, has been found in Pleistocene deposits in East Africa (131).

2. History of Scientific and Technical Research on Tilapia and Determination of Species

It was indicated in the first article that tilapia culture started its prodigious travels through warm countries in 1939. This is true as far as *T. mossambica* is concerned.

Since 1924, *T. nigra* have been kept in ponds in Kenya (22). Experiments started in 1937 in the Belgian Congo were intensified and organized on a scientific basis in 1946. Later, efforts in Africa were concentrated simultaneously on *T. melanopleura* and *T. macrochir* (6-17, 35, 47-52, 141), and, in the beginning, without contact with Far Eastern scientists working with *T. mossambica*.

Determination of Tilapia Species

The taxonomy of tilapia is difficult and not yet definitely established. The genus has numerous species, some of them recently discovered in Africa (148, 153). Work on simplification of the taxonomy and determination of species has been carried out, chiefly by Miss R.H. Lowe (now Mrs. R.B.M. McConnell), and Dr. E. Trewavas (146, 163, 164). Determination of the *Tilapia* species is best done by referring to these recent works, and by appeal to tilapia taxonomists.

3. Predators, Diseases and Parasites

Birds of prey feed heavily on tilapia in the African lakes. It is estimated that one full grown pelican (*Pelicanus roseus*) annually consumes between 1 metric ton (76) and 3 metric tons (98) of fish,

consisting mainly of tilapia; the former figure is queried by Copley (personal communication). A purple heron annually consumes about 100 kg. of tilapia (98).

Many writers (79, 80, 90) stress the fact that tilapias are liable to only few diseases or parasites. Copley, however, is of the contrary opinion (personal communication). Du Plessis (129) points out that in the Transvaal, *T. andersoni*, *T. melanopleura* and *T. mossambica* are attacked by three diseases and various parasites. A protozoon and a nematode have also been noted in Bunyoni Lake on *T. nilotica* at an altitude of 2,000 m. (6,564 ft.) (98). Since, in the Transvaal and Bunyoni Lake, tilapias are living at the uttermost limit of their natural ranges with respect to temperature, the occurrence of these diseases is perhaps not surprising, and the opinion that tilapia is not readily susceptible to diseases or parasites under its normal living conditions might, therefore, be sustainable.

4. Transplantation of Tilapia

(*a*) *Tilapia mossambica*

This species was introduced into Japan in the summer of 1954 and was bred there at a piscicultural research laboratory. It is kept in warm springs during the winter so that it may be used for pisciculture during the following summer (Katsuzo Kuronuma, cor.).

In 1954, *T. mossambica* was introduced, for culture trials, to the Fiji (Polynesia) Islands from Singapore (165).

During 1955, a rough release of *T. mossambica* was made in Lake Susupe in Saipan, Marianne Islands (Micronesia) (109); it was introduced into Laos (111) and South Korea (104) from Thailand, to Guam (166) and New Caledonia from the Philippines (167), and into the Cook Islands from Fiji (115). *T. mossambica*, though originating in Africa, was introduced into Egypt from Thailand in 1954 (151).

(*b*) *Other Species of Tilapia*

During the past 20 years the British East African Fisheries Service has introduced tilapias into isolated lakes where there were unused food resources (98, 146). The introduction of *T. nilotica*, an omnivore, was a success in Uganda in Lakes Nakivali, Kachira, Kijanebalola and Bunyoni, as well as in a number of smaller waters. *T. nilotica*, a few years after its introduction into Lakes Nakivali and Kachira, was giving an annual catch from 200 to 230 kg. per ha. (98). On the other hand, attempts to introduce *T. esculenta* into Lakes Kachira and Bunyoni, and *T. nigra* into the latter lake, were a failure (98). The introduction of *T. nigra* into Lake Navaisha was successful, however (22).

II. Biology of Cultivated Tilapia Species

1. *Tilapia mossambica*

T. mossambica was killed by temperatures of 10° C. (21, 96), and 8° C. (137).

Nutrition. *T. mossambica* is the only artificially cultivated fish reported to feed on *Euglena sanguinea*, the well-known alga forming red layers on the water in ponds and fields (160).

2. *Tilapia melanopleura*

Distribution. This species was introduced into Brazil in 1953, and Thailand in 1955. It may be introduced into other tropical countries with *T. zilli*, since there is a need for plant-eating pond fish.

3. *Tilapia macrochir*

T. macrochir suffered from an oxygen deficiency in some Northern Rhodesian marshes after two seasons with too little rainfall.

4. *Tilapia nigra*

Distinctive characteristics of this species: D: XVII/11-12; A: IV/9; 32 scales. There are 25 gill rakers in the first branchial arch; four, sometimes five, anal fin spines.

Origin and ecology. This species originates from Kenya and Uganda and is found particularly in the Athi and Tana rivers (123). It occurs in consistently warm waters and is more susceptible to cold than either *T. mossambica* or *T. macrochir* (49).

Reproduction. Incubation is carried out in the mouth of the female as in the case of *T. macrochir*. The male differs from the female both by larger size and by secondary sexual characteristics, such as the color of the body and fins. It reproduces in ponds from the size of 11 to 16 cm. (124) and the age of four months and spawns every three months (123).

Distribution. This species has been cultivated for the past 25 years in Kenya, in Uganda, and in the warmer waters of the northern part of the Belgian Congo (Maniema, Kivu) (49), but its culture in ponds, even in these three regions, is still of little importance (6, 22, 49, 84, 123, 141). Attempts to cultivate *T. nigra* have failed in Rhodesia (83), in the Union of South Africa (85), and in Madagascar (73). *T. nigra* has been successfully introduced into Lake Naivasha (22), but was unsuccessful in Lake Bunyoni (163).

Feeding habits. *T. nigra*, like *T. macrochir*, is an omnivore, taking food from the bottom, such as insects, mollusks, worms, debris and, above all, green filamentous algae (123), epiphytes or epilithics (118). It does not feed on higher aquatic vegetation.

Growth. In the early stages this species grows as rapidly as *T. macrochir* and *T. melanopleura*; it reaches a length of 5 cm. in

two to three months and 10 cm. in four to six months (118). Thereafter its growth slows down. The male grows more quickly than the female and the difference in size is noticeable even before it matures sexually (118). This difference amounts to 2 cm. when the fish are four to five months old, having reached an average length of 10 cm. (118). When reared in monosex culture the fish reaches a length of 20 cm. in nine to ten months; in open waters, such as the Athi river, it can reach as much as 1 kg. in weight (123).

Methods of Transporting Tilapia

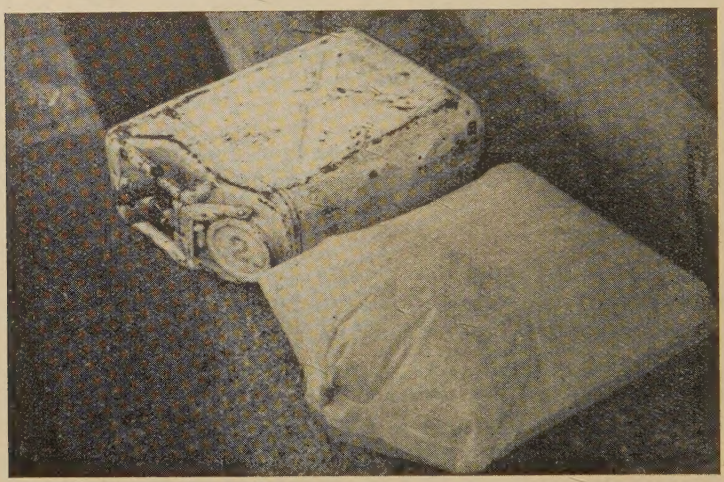

Figure 3. Transportation of tilapia in jerrycans and plastic bags under oxygen pressure. (Photo: M. Huet)

III. Methods of Tilapia Culture

1. *Tilapia mossambica*

It has been estimated that in Indonesia about 100 to 150 metric tons (157) of *T. mossambica* are produced daily from ponds and open waters. The maximum yield from ponds (17.8 metric tons per ha. per year) has been recorded in Thailand, obtained by means of heavy manuring and artificial feeding (154). *T. mossambica* is cultivated in the whole of the Far East, including India (103); in Oceania (165, 166, 168); in the Caribbean (66); and in Africa (Southern Rhodesia) (99).

Since the chief difficulty in tilapia culture is to control reproduction, and avoid unmarketable pigmy fish, two methods are now under experiment; control by predators, and monosex culture. Theoretically, a third method could be tried by crossing two tilapia species and obtaining sterile hybrids.

(*a*) *In Fresh-water Ponds*

Control of overcrowding by predators. In an experiment undertaken in Thailand (154) a fertile pond highly fertilized and receiving artificial feed was stocked with *T. mossambica* and some predators (*Ophicephalus*, *Clarias*). After one year, the total yield was very high, 87 % being composed of tilapia of an average weight of 150 g. A similar experiment, with few predators, gave only 10 % tilapia of an average weight of 150 g.

Figure 4. Family ponds in Java stocked with tilapia, carp and other species. (Photo: M. Huet)

(*b*) *In Brackish-water Ponds* (*tambaks*)

During and just after the second World War, *T. mossambica* was cultivated in the Far East brackish-water ponds, because Chanos fry were rare, and chiefly because it was not possible to provide good maintenance of pond embankments (79). Now, *T. mossambica*, although giving most of the yield, seems less popular among the brackish-water pond farmers of Indonesia and the Philippines, who get better prices for chanos and shrimps. It is recorded by R. Djajadiredja, in an incidental paper of the Third Bogor Inland Fisheries Training Center, 1955, that in the western part of Java, *T. mossambica* is used as a substitute for chanos when chanos fry prices are too high, or for undrainable ponds where the presence of predators causes a high mortality.

(c) *In Rice Fields*

T. mossambica is the only cultivated fish that can feed on *Euglena sanguinea*, which often forms red layers in rice fields (160). A great advantage of the culture of *T. mossambica* in rice fields is that the fish feed on the green algae which compete with rice plants in the absorption of nutrients. Part of the nutrients is returned

to the field through the faeces of the fish (160). A further advantage is that by keeping the algae down, more sunlight can penetrate the water. Pisciculture in rice fields, however, requires water greater in amount and depth than common types of rice can tolerate (160). Research in this field has only just been initiated, especially so far as Tilapia is concerned (160). Apart from Indonesia, the Philippines and Taiwan (Formosa) (21, 112, 113), *T. mossambica* has been tried in rice fields in Ceylon (113).

Figure 5. Stocking fry (carp, tilapia) in a rice field in central Java (Photo: M. Huet)

(*d*) *In Sewage-water Ponds*

T. mossambica in sewage-water ponds receiving the effluent from cities, mixed with fresh water, gives a higher yield than other species, up to 7,000 kg. per ha. per year, in Indonesia (106), and 1,100 kg. in South Africa (137).

(*e*) *In Mixed Culture*

T. mossambica is cultivated in mixed culture:

(*i*) in fresh-water ponds with common *Puntius*, *Osteochilus* (157) and with Indian major carps (103). In the latter case, the annual tilapia yield attains 3,000 kg. per ha. but the growth of major carps appears to be greatly affected (103);

(*ii*) in brackish-water ponds with chanos (79);

(*iii*) in rice fields in Indonesia with carp and *Puntius* (140);

(*iv*) in sewage-water ponds in Indonesia with carp and *Helostoma* (106).

(f) In Monosex Culture

Monosex culture experiments with *T. mossambica* are being tested in Jamaica (T.W. Burdon, verbally), Indonesia and Sarawak (141). There are two phases in this culture:

(*i*) to obtain and rear the fry to fingerling stage, when it is possible to determine sex;

(*ii*) to segregate the sexes, placing each in its own pond (141).

Figure 6. Intermediate catches of T. mossambica in a big pond near Bandung, Java. (Photo: M. Huet)

Figure 7. Fry market in Java for tilapia, carp and other species. Fry are transported in special impermeable baskets, carried on the shoulders of countrymen who cultivate fish in ponds and rice fields. (Photo: M. Huet)

2. *Tilapia melanopleura and Tilapia macrochir*

Methodin use in French Equatorial Africa. T. melanopleura is generally considered as a good weed eater,except by a few authors (126, 127). *T. melanopleura* and *T. macrochir* are also cultivated in Northern Rhodesia (100). The necessity for periodical removal of *large and average sized* fish is stressed (120, 121, 144); draining the ponds is unnecessary except to determine the number of fish present, to control overstocking, or to recondition the pond.

Overstocking is not a danger to be guarded against in " family " pisciculture because, in this case, even the young fish are caught and eaten (121). In commercial pisciculture, however, a predatory species must be introduced to prevent overstocking (144, 154). Present research is concerned with finding a practical means for the African fish-culturist to obtain a regular supply of fish without having to drain the pond (121). *T. macrochir* and *T. melanopleura* are excellent transformers of cheap artificial food (120).

Trials are being made of monosex culture (123). This method is unsuitable with *T. melanopleura* in which size difference between the sexes at the fry stage is insufficient to permit identification of the sexes, nor is there any other detectable sex difference (127, 141).

3. *Tilapia nigra*

This species is cultivated only in parts of Kenya, Uganda and the northern part of the Belgian Congo where the waters are consistently warm (49, 141). Attempts to cultivate it elsewhere have not given good results (96, 137). In dry countries, on the other hand, water is precious and of greater value than fish; and since fish culture in ponds involves use of considerable quantities of water, it is practised on only a small scale (123).

Ordinary methods. T. nigra is cultivated either in pure stock or together with *T. melanopleura.* Production is less than in the Belgian Congo as no artificial food is added to the ponds. Yields vary from 300 kg. per ha. (110) to a maximum of 400 to 550 kg. per ha. (123); expectations of improving these yields have no solid basis (123).

Method of using fixed wattles. T. nigra feeds on filamentous algae which prefer a solid substratum lacking in ponds with a slimy bottom. In such ponds, wattles consisting of papyrus stems or brushwood are fixed in an east/west direction in order to cast minimal shadow. Algae grow on the wattles and the yield is thereby increased by 15 to 20 % (118) and can be improved still further if the wattles are smeared with lime or other nutritive substances (118).

Monosex culture. This method has been described by Brown and van Someren (118); research is still being carried on by Hickling. The method is based on the different growth rates of the two sexes, which are cultivated separately with the double object of avoiding overcrowding and loss of weight due to exhaustion from spawning. Fry, 5 cm. long, are taken from a small pond, stocked with one pair

of breeders. They are placed in a separate fry pond, stocked to a density of about 2,500 fry per ha. When they have reached an average length of 10 cm., two to three months later, the difference in length between the sexes amounts to about 2 cm. The average length for each sex is calculated on the basis of a sample of 100 individuals. All fish above a determined size limit are, theoretically, male. These males are then selected and placed in a separate pond to reach the commercial size of 20 cm. in eight to nine months; the females can be raised separately. The normal yield is 300 kg. per ha. (118). This can be increased either by adding artificial food or by fixing wattles. The latter method is efficient and deserves further study but it seems complicated for the scope of the average fish culturist.

Until now *T. nigra* is the only tilapia to which monosex culture is applied in practice and, even so, only on a restricted scale (141). For other species, such as *T. mossambica* and *T. kafuensis* in Northern Rhodesia (167), the method has been applied only experimentally. It must be noted that in many of the East African tilapias, the two sexes grow at the same rate (146) e.g. *T. melanopleura* (141).

4. *Tilapia galilaea*

Some trials have taken place in Israel with *T. galilaea* as secondary fish in carp ponds (155, 158, 172).

T. galilaea is a plankton feeder and gives marketable fish (more than 100 g.) at the end of a year, i.e., after two growing periods of about 150 days. It does not spawn during its first year and some losses occur in winter (158).

When no artificial feed for carp is introduced but there is intensive fertilization, a mixed culture of carp and *T. galilaea* is recommended and gives yields 18 to 56 % higher than from culture of carp alone (155).

However, if artificial food is given, a mixed culture of carp and *T. galilaea* would not be productive, the total yield being the same as that produced by culture of carp alone for which there is a better price (158). The daily weight can vary from 0.5 to 3 g. (172).

5. *Tilapia sparmanni*

This species has been used experimentally in the Belgian Congo, but its rearing is at present abandoned there because it reproduces when still small (49). However, it has two important qualities: it is the tilapia most resistant to cold weather, sustaining temperatures as low as 7° C. (137, 138) and it feeds on algae and aquatic plants (116). It can therefore be used in combination with black bass (*micropterus*) as a much better forage fish than blue gill (*Lepomis macrochirus*) (116, 129, 137). It is cultivated for this purpose in South Africa. This species is not a mouth-breeder and spawns when the temperature rises above 16° C. (129).

IV. Introduction of Tilapia into Barrier-lakes and Reservoirs

Barrier-lakes and reservoirs are built for different purposes, but their main use in tropical countries is to store water for agriculture and animal husbandry. A secondary use is the production of fish by methods cruder than those of pond culture, but more advanced than those practised in natural open waters. Improvement of the fisheries of lakes and reservoirs involves stocking with chosen species, enforcement of restrictions on fishing and, later, regular fishing with net or line and control of the size of the stocks. Draining, which can be undertaken only when permitted by the main utilization of the barrier-lake or reservoir, is used to control stocks, predators and vegetation. Tilapia is often used to stock these waters because it is hardy and easy to catch (98). Research in this field has been undertaken by the Uganda Fisheries Service, working in co-operation with the East Africa Fisheries Research Organization (98, 146, 147). *T. esculenta*, a plankton feeder, produces stunted progeny in these artificial lakes and reservoirs, whereas *T. nilotica*, an omnivore, does not reproduce at all. Better results have been obtained with *T. zilli*, *T. leucosticta*, and *T. variabilis* (149). *T. zilli*, an excellent table fish, grows rapidly in barrier-lakes (98, 146, 147, 164), reaching 10 cm. in three months, 20 to 24 cm. in seven months and 26 to 29 cm. with a weight of 300 to 450 g. in one year. The maximum weight it attains is 800 g. (98, 147). The advice given below concerning barrier-reservoirs in Uganda was sent by Miss R.H. Lowe (*see also* 102).

(*a*) never stock with other than known species of Tilapia from a reliable source ;

(*b*) stock with several species of Tilapia so as to make advantageous use of the different types of food available; *T. zilli*, a plant feeder, can, for instance, be mixed with *T. leucosticta* and *T. variabilis*, both omnivores; the last also takes soft, submerged plants;

(*c*) *T. zilli* feeds on submerged aquatic vegetation ;

(*d*) the stocking can be advantageously completed with species other than tilapia such as:

Clarias, a predatory fish which will prevent Tilapia from overcrowding ,

Alestes macrophtalmus and *Distichodus* species, to keep down Nuphar not eaten by *T. zilli*,

Astatoreochromis allaudi, to destroy mollusks, which are carriers of helminthic diseases, such as Bilharzia.

In Indonesia, *T. mossambica* is used largely to stock barrier-lakes and reservoirs, but it does not give good results in canals because it swims downstream (156).

V. Various Uses of Tilapia

1. Struggle Against Malaria

T. mossambica feeds on long green algae (Enteromorphae, Chaltomorphae) which cover the surface of many tropical ponds. Mosquito larvae shelter in these masses of largae from small larvivorous fishes, such as *Gambusia*, *Lebistes*, *Panchax* (79, 139). *T. mossambica* therefore provides an excellent indirect control of malaria (139). Experiments made in Indonesia show that, in the same pond, the surface can be entirely free of, or entirely covered with, green algae, depending on whether tilapias are present or absent (139).

2. Pig Raising in Combination with Tilapia Culture

On a farm in Malaya, excellent technical and financial results are obtained when pig dung is flushed into tilapia ponds. Thus, the growth of algae, and consequently of tilapia, increases without any cost. This system produces more tilapias for human consumption and, moreover, increases the growth of the aquatic plant Ipomoea, which thrives in the pond, and is used to provide green food for pigs (145).

A supplemental improvement now exists in the Agriculture Station in Fiji; large tilapias are used for human consumption, and small tilapias for pig food, supplying proteins, while Ipomoea provides vegetable food for the pigs.

Such a fish pond, manured by pig pens, can produce, without cost, 100 kg. of Ipomoea and 8 kg. of tilapia per ha. each day (165).

3. Live Bait for Tuna Fishing

The euryhalinity and rapid reproduction of *T. mossambica* make it suitable for use as live bait for tuna fishing in the Hawaii Islands, replacing small marine fish which are often unavailable (117, 130). These uses open up new prospects for tilapia culture in tropical countries and appear to be an excellent use for easily stunted populations of tilapia. The best live bait fish for tuna fishing in Hawaiian waters are 3 to 8 cm. in length (2.5 g.). The results of the first experiments were excellent, both to hold a school of tuna and to catch them with hooks baited with tilapia (117).

4. Forage Fish

In South Africa, *T. sparmanni* is considered a better forage fish (96, 97, 129, 137) for large-mouth black bass (*Micropterus salmoides*) than bluegill (*Lepomis macrochirus*), because:

(*a*) it eats mainly algae and aquatic weeds; the bluegill is chiefly carnivorous ;

(*b*) it does not compete with young bass; on the other hand, bluegill does and it is also a predator of bass fry ;

(*c*) it is tolerant to a relatively low water temperature (7° C.). The maximum length of *T. sparmanni* is 20 cm. Its use as a forage fish could give some extension to this species in countries with a Mediterranean climate. Tilapia caught in open waters has been used as a cheap food on Kenya trout farms (125).

BIBLIOGRAPHY*

(95) Anon. *Report on Fisheries Investigations 1942-1948.* Government printer, 1948 Lagos, Nigeria.

T. hendeloti and *T. melanopleura* form a large part of the total catch in lagoons. They are stocked in ponds but more for anti-mosquito purposes than for fish culture.

(96) ————. Fish Populations. Inland Fisheries Department, Provincial Administration of the Cape of Good Hope, Union of South Africa, *Report,* 1950 (7) : 17-19.

Attempts to acclimatize *T. melanopleura, T. nigra* (from Kenya), *T. macrochir,* and *T. andersoni* at the Jonkershoek Hatchery failed because of climatic conditions. *T. mossambica* was distributed in the province but extensive " kills " occur in winter. The minimum temperature tolerated is approximately 10°C. *T. mossambica* is cultivated in ponds at Athlone. *T. sparmanni* is able to tolerate a temperature of 8°C. and is considered superior to the bluegill sunfish (*Lepomis macrochirus*) as a forage fish.

(97) ————. Fieldworks and Surveys. *Ibid.,* (8) : 8.
1951

T. sparmanni is stocked in dams as a forage fish for large-mouth bass (*Micropterus salmoides*) and spotted bass (*M. punctulatus*).

(98) ————. *Annual Report of the Game and Fisheries Department for 1952.*
1953 Government printer. Entebbe, Uganda.

Annual production of fish in Uganda, including the Uganda section of Lake Victoria, is worth about one million pounds sterling and the greater part of the catch consists of tilapia. The report gives statistics for the different lakes and the results of studies made with a view to the improvement of fishery management in inland waters. The introduction of tilapia, mainly *T. nilotica,* into many lakes is noted and reference is made to successful results obtained in Lakes Nakivali and Kachira where the yields of tilapia reach 200 kg. per ha. annually.

Many barrier-lakes and reservoirs have been successfully stocked with *T. zilli, T. leucosticta* and *T. variabilis.* A continuous battle is being waged against the natural foes of tilapia, such as pelicans and crocodiles.

(99) ————. Henderson Research Station. *Annual Report 1953.* Southern
1953 Rhodesia. Mimeo.

The experimental fish pond farm is producing fry of *T. mossambica* for stocking. In ponds fertilized with compost and manure, the yield for nine months was about 1,700 kg. per ha.

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* The serial number of references is in continuation of the 94 items cited in the previous article by the author.

(100) ANON. *Fish Farming in Northern Rhodesia Progress 1952/53.* Government
1954 printer, Lusaka, Northern Rhodesia.

At the end of 1953, 286 dams representing 2,985 acres existed in the territory. *T. macrochir* and *T. melanopleura* are cultivated. The Chilanga station supplies tilapia fry and gives an average annual yield of 3,350 kg. per ha. with artificial feeding.

(101) ————. *Administration Report of the Acting Director of Fisheries of Ceylon*
1955 *for 1954.* Government Publications Bureau, Colombo, Ceylon.

T. mossambica was stocked in many village tanks and ponds; rearing in rice fields was successfully tried.

(102) ————. *Annual Report of the Game and Fisheries Department for 1953.* Go-
1955 vernment printer, Entebbe, Uganda.

The annual yield of fish in the open waters of Uganda, including the Uganda section of Lake Victoria, reaches 23,000 metric tons per annum. Catches consist mainly of tilapia and yields are on the increase. Lakes Nakivali and Kachira are giving annual yields of about 230 kg. per ha. Introduction of tilapia into isolated lakes is continuing. The stocking of barrier-lakes and reservoirs with *T. zilli*, *T. leucostica*, and *T. variabilis* is also being continued successfully and the production is satisfactory.

General advice is given on stocking barrier-lakes with tilapia in accordance with the findings of the Jinja Research Station.

(103) ————. *Annual Report of the Department of Fisheries, Bombay State, for*
1955 *the Years 1954/55.* Government Publications Sales Depot, Institute of Science Building, Fort, Bombay, India.

T. mossambica has been introduced into Bombay State from Travancore. Tilapia fry are distributed to pond owners. Tilapia cultivated in a tank together with major carps have given a yield of about 3,000 kg. per ha. without artificial feeding or manuring. However, the growth of major carp appears to be greatly affected by tilapia.

(104) ————. Republic of Korea, Tilapia Received from Thailand. *Comm. Fish.*
1955 *Rev., 17* (7): 65.

In May 1955, 470 *T. mossambica* were sent from Thailand to South Korea.

(105) ————. East African Fisheries Research Organization. *Annual Report*
1954-1955, Jinja, Uganda, East Africa. pp. 64-74.

Some bionomic studies, including variable density and distribution, have been made on *T. esculenta* and *T. variabilis* of Lake Victoria. The young of *T. esculenta* inhabit water lily swamps and later move to more open water. There is now some danger of overfishing existing stocks of tilapia in Lake Victoria. *T. zilli*, a vegetable feeder and not a mouth-breeder, has done well in ponds ranging in altitude from 914 m. (3,000 ft.) to 2,512 m. (8,500 ft.) Otelia ulvifolia is noted good fodder for *T. zilli*. In Lake Kyoga, *T. zilli* is able to attain a weight of 2 kg. rising to 3 kg. maximum. Sexual maturity in lakes occurs when the fish reach a length of 27 cm. The eggs of *T. variabilis* have been fertilized with spermatozoe from *T. esculenta* but the embryos died, which means that there may be some danger for the future existence of both species when they are in the same habitat. Rings on tilapia scales and the growth of very young tilapia have also been studied.

The publication includes as Appendices A and C, papers on "The Danger of Overfishing Existing Stocks of Tilapia with Particular Reference to Lake Victoria and the Kavirordo Gulf," by R.S.A. Beauchamp and "Ring Formation in the Scales of *Tilapia variabilis* Boulenger and *Tilapia esculenta* Graham from Lake Victoria," by M. J. Holden.

(106) ————. Fish Culture in Sewage at Krapjak (Djogjakarta). Third Inter-
1955 national Inland Fisheries Training Center at Bogor (1955). Incidental paper (19) FAO, Rome, Italy. Mimeo.

T. mossambica is raised alone or with other species (carp, *Helostoma*) in ponds receiving sewage from the towns (e.g., Djogjakarta). *Tilapia* gives the highest yields (up to 7,000 kg. per ha. per annum).

(107) ————. Note sur les essais au Centre d'Alevinage Principal de Gandajika.
1955 *Bulletin*, Service des Eaux et Forêts, Chasse et Pêche, Léopoldville, Belgian Congo. *5* (17): 201-38.

The growth of *T. macrochir* and *T. melanopleura* is not as good in Kasai as it is in Elisabethville. Artificial feeding is necessary to obtain good yields.

(108) ————. Tilapia. *Progr. Fish. Cult., 17* (2): 86.
1955

Advice to those wishing to introduce *T. mossambica* into the United States of America. The U.S. Fish and Wildlife Service opposes the introduction of this species because *T. mossambica* is more suitable for tropical than for temperate waters, and yields large quantities of small-size fish, which have economic value only in those countries where there is a deficiency of proteins.

(109) Aronson, L. R. and E. T. Shaw Street, New York.

1954. Oral incubation in Tilapia macrocephala. Bulletin of the American Museum of Natural History, 103: Article 5. Manila (Philippines) s, Micronesia).

(110) *Research Unit. July* lan.

stomach contents in mid larvae.

(111) Discusses some of the life history of T. macrocephala. Council (16). FAO, introduced into Laos

(112) AJHAR, M. Rice Field Fish Culture in Indonesia. Third International Inland 1955 Fisheries Training Center, Bogor, 1955. Lecture 5.64. FAO, Rome, Italy. Mimeo.

T. mossambica is one of the species cultivated in rice fields in Indonesia.

(113) ALIKUNHI, K.H. Rice Field Fish Culture Outside Indonesia. *Ibid.*, Lecture 1955 5.63. Mimeo.

In the Far East, *T. mossambica* is used to stock rice fields in Indonesia, the Philippines and Taiwan (Formosa). Trials are carried out in Ceylon.

(114) ARONSON, L. Tilapia, the Brooding Father. *Nat. Hist., N.Y.*, Match.

A study on sexual behavior and mouth-breeding of *T. macrocephala* (or *T. hendeloti*) in aquaria.

(115) BEDELL, R.C. Commission holds Fourteenth Session, 1956. South Pacific 1956 Commission, Noumea, New Caledonia, *Quarterly Bulletin*, January.

T. mossambica was introduced from Fiji into the ponds of Cook Islands in 1955.

(116) BRAND, D.J. A Comparison between the Diets of *Tilapia sparmanni* and the 1954 Bluegill Sunfish, *Lepomis macrochirus*. Provincial Administration of the Cape of Good Hope, Department od Nature Conservation, Union of South Africa, *Report* (11): 55-58.

T. sparmanni is considered in South Africa to be a food forage fish for largemouth bass (*Macropterus salmoides*), better than bluegill. *T. sparmanni* does not compete with young bass, and eats: zooplankton at the first stage (maximum length 6 cm.); zooplankton, insects and algae at the second stage (maximum length 10 cm.); algae and aquatic plants (*Nitella, Anacharis, Sagittaria*) (length above 10 cm.).

(117) BROCK, VERNON E. and TAKATA, M. Contribution to the Problems of Bait 1955 Capture and Mortality together with Experiments in the Use of Tilapia as Live Bait. Industrial Research Advisory Council, Hawaii, *Final Report* (49): 39-40.

In December 1956, 60 specimens of *T. mossambica* were introduced into Hawaii from Singapore. Most of them were killed by ichthyophtirhiasis. The few survivors multiplied and Tilapia is now well established and cultivated in the major Hawaiian Islands. Tilapia can spawn in brackish water with a salinity of about 20 %. In fresh-water irrigation reservoirs it can give an annual yield of about 500 kg. per ha. It is used as live bait for tuna (*Katsuwonus pelamis*) when 3 to 8 cm. (2.5 g.) long. Tilapia are transferred directly from fresh into brackish water at 18 % (duration 8 hours) and slowly moved into sea water over a period of 3 days. First experiments with tilapia in tuna fishing had given good results, both to hold a school of tuna, and to catch them with hooks, baited with tilapia. There is a future for tilapia culture in brackish water, alone or mixed with mullets.

(118) BROWN, J.M. and VAN SOMEREN V.D. New Fish Culture Method for Tilapia in 1953 East Africa. *Nature, Lond., 172* (4373): 330-32.

This study of *T. nigra* deals with the different growth rate of the two sexes and the retardation of production of large fish due to spawning, which also brings about over production of small fish. It also deals with monosex culture techniques. The sexes are separated when they reach a length of 10 cm., at the age of about six months, and when the difference in length between the sexes is 2 cm. The larger fish are then taken out; these theoretically are all male. Furthermore, in order to support and stimulate the growth of the algae, on which the fish feed, a screen made of papyrus stems is put into place. In monosex culture tests, using the males only, good results were obtained with *T. nigra* but not with *T. melanopleura*. The authors consider that this method is easier than distributing artificial and natural food and taking a large catch periodically.

(119) BRUNELLI, GUSTAVO. Considerazioni sulla Pesca e la Pescosità del Tana. 1940 Estratto da Missione di Studio al Lago Tana. *Ricerche di Limnologia Biochimica e Biologia*, Reale Academia d'Italia, Rome, Italy, *3*.

T. nilotica is present in considerable quantities in Lake Tana.

(120) CHARPY, B. *Rapport de la Station de Pisciculture de la Djoumouna.* Eaux et 1955 Forêts, Brazzaville, French Equatorial Africa.

The soil of the ponds is very poor, and the natural productivity low (250 kg. per ha.). Fish growth in these small ponds is directly proportional to the artificial food given, and to the quality of this food.

Oil cakes (peanuts) give better yields when used for feeding *T. macrochir*, vegetables (manihot leaves) when used for *T. melanopleura*, with the following conversion rates :

1 kg. fish = 1.5 to 4 kg. of a mixture of $^2/_3$ peanut cake and $^1/_3$ manihot leaves.
1 kg. fish = 6 to 12 kg. of a mixture of rice bran and manihot leaves.
1 kg. fish = 12 to 20 kg. of a mixture of manihot leaves only.

Trials have been made on monosex culture and on cultivation of *T. galilaea* and *T. nilotica*.

(121) ————. La pisciculture du tilapia. *Bull. franc. piscic., 27* (178) ; 5-20. 1955

The author describes the experiments made at the Djoumouna Station in the culture of *T. melanopleura* and *T. macrochir*, and the studies on growth of populations in ponds. Tilapia culture is valuable only if artificial food (peanut cakes, manihot leaves, etc.) is given. With a daily rate of artificial food of 5 % of the fish weight (using the same quantity from the beginning to the end) the yield Y at the month X after stocking is given by the formula $Y = P \times 1.3\ X$, P being the initial stocking. Overcrowding by small-sized fish is the worst drawback in tilapia culture but in Africa the problem of quantity of proteins is now more important than the problem of quality. Intermediate catches are necessary but this represents a difficult problem. If the biggest fishes are eliminated by intermediate catches, an inverse selection of breeding results. The method for tilapia culture in familial ponds has already been described : stocking, waiting for three months and then intermediate fishing for three months, draining ; then a new cycle of another six months begins. Annual yields of above 4 tons per ha. can be expected.

(122) CHIMITS, P. *Report on the Fish-cultural Possibilities of the Azraq Project in* 1956 *Jordan.* Administrative Report to FAO, Rome, Italy.

Two species of tilapia have been found in the Azraq marshes : *T. zilli*, a vegetable feeder, able to consume coarse vegetation, such as *Chara* : *T. nilotica*, an algae and plankton feeder.

(122*a*) ————. Tilapia and its Culture. A preliminary bibliography. *Fish. Bull.* 1955 *FAO, 8* (1) : 1-33.

Besides a preliminary review of the information on various aspects of tilapia and its culture, a list of 94 references with annotations is furnished.

(123) COPLEY, H. The Tilapias of Kenya Colony. *E. Afr. agric. J. 18* (1). 1952

The genera of Tilapia (60 species) and of Paratilapia (30 species) are widespread throughout Africa and eastward as far as Syria. These two genera appear to date from the Oligocene era and originated in the eastern part of South America where 140 species of Cichlidae still occur.

After describing several species of Tilapia (*esculenta, melanopleura, mossambica, nigra* spp.) and noting their morphological differences, the author goes on to describe spawning. According to him, *T. melanopleura* and *T. mossambica* make a nest but take no interest in their young after they have hatched.

The drawback in breeding tilapia in closed waters is that they reproduce precociously with a resultant over production of small fish. It is unrealistic to expect yields of 454 to 908 kg. per acre, but 181 to 227 kg. annually per acre of fish of an economically satisfactory size should be obtainable.

T. nigra is an omnivore ; *T. melanopleura* takes solely vegetable food from the time it reaches a length of 12.5 to 15 cm.

(124) ———— and BLICHFELDT-PETERSEN. Fish Culture Farm Report. *Review* 1952 *of Kenya Fisheries, 1951.* Government printer, Nairobi.

Pond culture trials with *T. melanopleura* and *T. nigra* have been carried on at the fish culture farm. *T. nigra* spawns when 11 to 16 cm, long.

(125) COPLEY H. and MARTINDALE T.N. Trout Hatchery. *Ibid.*, 1952. 1953

Tilapia caught in open waters can be used as a cheap trout food on trout farms.

(126) COPLEY, H. and BROWN, J.M. Sagana Fish Culture Farm. *Ibid.* 1953

T. nigra has given more promising results than *T. melonopleura* in pond culture without fertilization and artificial feeding. Until now, *T. melanopleura* has not proved to be a good weed eater.

(127) COPLEY, H., BROWN, J.M. and VAN SOMEREN V.D. *Review of Kenya Fisheries* 1953 1952. Government printer, Nairobi.

T. melanopleura does not grow faster than *T. nigra*, does not breed so freely, cannot be readily sexed, is not readily netted and is far inferior to *T. nigra* from the handling point of view. Its weed-eating capabilities have yet to be proved. Immature *T. nigra* can easily be separated by sexes. *T. nigra* is much better from the viewpoint of monosex culture.

(128) DU PLESSIS, S.S. Observations on the Habits of *Tilapia sparmanni*. Pro- 1945 vincial Administration of the Cape of Good Hope, Union of South Africa. Inland Fisheries Department, *Report* (2) : 8-9.

T. sparmanni is used as forage for adult bass. Breeding begins when the temperature rises above 16°C. This species is not a mouth-breeder.

(129) ————. Fish Diseases in the Transvaal. *Record of a Symposium on African* 1954 *Hydrobiology and Inland Fisheries held October 1952, at Entebbe, Uganda,* pp. 128-129. Secretary-General CSA, Bekavu, Belgian Congo.

Three diseases and parasites have been found on tilapia in the Transvaal : (*i*) a bacterium on the fins of *T. melanopleura* and *T. andersoni* which causes a serious disease. Treatment : a 2-minute batch in a 1/2,000 solution of copper sulphate ; (*ii*) a dactylogyrus on *T. melanopleura*. Treatment : a 20-minute bath in a 1/4,000 solution of formol ; (*iii*) a chilodon on the gill rakers of *T. mossambica*.

(130) ELLIOT, E. Its Mouth is its Nursery. *Nat. Hist, N.Y.*, *64* (6) : 330-33 1955

In the Hawaiian Islands, *T. mossambica* is now being used as live bait for tuna fishing, because the local bait (nehu) is rapidly disappearing. This is an important opening for fish culture in salt-water lakes, owing to the euryhalinity of tilapia and the facility with which it breeds.

(131) GREENWOOD, P.H. Fish Remains from Miocene Deposits of Rusinga Island 1951 and Kaverondo Province, Kenya. *Ann. Mag. nat. Hist.*, Ser. 12, *4*. December.

Miocene cichlids closely related to *T. mossambica* have been found in the Tana system (Kenya). *T. nigra* have been discovered in Pleistocene deposits in Kenya.

(132) ————. Feeding Mechanism of the Cichlid Fish, *Tilapia esculenta* Graham. 1953 *Nature, Lond., 172* (4370) : 207-8.

T. esculenta feeds on phytoplankton, and on filamentous algae which it cuts in uniform lengths by the regular movement of pharyngeal bones and teeth.

(133) GRUVEL, A. *Les Etats de Syrie*. Bibliotèque de la faune des Colonies fran- 1931 çaises. Société d'Éditions Maritimes, Paris.

T. galilaea and *T. nilotica* are abundant in Lakes Huleh and Tiberias.

(134) HAWKINS, G.J. and MORTIMER A.E. Fish Farming in Northern Rhodesia. 1952

T. andersoni, *T. macrochir* and *T. melanopleura* are valuable for fish culture in Northern Rhodesia.

(135) HARRISON, A.C. Fresh Water Fish of the Cape. Provincial Administration of 1952 the Cape of Good Hope, Department of Nature Conservation, Union of South Africa. *Report* (9).

T. mossambica is indigenous in the estuarine zone of the rivers northeast of Port Elizabeth.

(136) HEY, D. *The Establishment and Maintenance of Fresh-water Fish in South* 1941 *Africa*. Inland Fisheries Department, Cape Provincial Administration, Stellenbosch. Union of South Africa.

T. melanopleura and *T. mossambica* have been cultivated in the Transvaal and have met with favor as table fish. This article describes spawning and cultivation, which involves the use of fertilizers and the introduction of soft-tissued plants, such as *Nitella* and *Lagarosiphon*.

(137) ————. Programme of Fish for Food. Provincial Administration of the 1953 Cape of Good Hope, Department of Nature Conservation, Union of South Africa. *Report* (10), 51-60.

Experiments have been carried out at the Jonkershoek Station on acclimatization of six tilapias : *T. andersoni*, *T. kafuensis*, *T. melanopleura*, *T. mossambica*, *T. nigra*, *T. sparmanni*. The only species which survived and breed after the winter temperature of 8°C. were : *T. mossambica* and *T. sparmanni*, but the former has a high mortality when the temperature drops below 8° C. Both species are cultivated at Jonkershoek hatchery and the fry is distributed for stocking. *T. mossambica* seems

of interest for fish farming only in certain areas of the province. *T. mossambica* and *T. sparmanni* in fertilized ponds with artificial feeding can give a yield of 340 kg. per acre per annum. In conservation dams, a combination of black bass and *T. sparmanni* (forage fish) gives better results than a bass-bluegill combination. In sewage water ponds, the best results (about 454 kg. per acre per annum) are obtained with *T. mossambica*.

(138) HOFSTEDE, A.E. *Report to the Government of Israel on Inland Fisheries.* *FAO* 1955 *Report* No. 327, 56 pp. FAO, Rome, Italy.

Although fish culture in Israel is devoted almost entirely to carp, some local species of tilapia (*T. galilaea, T. nilotica T. zilli*), can enter the ponds and are cultivated with carp. Experiments are under way with pond culture of *T. galilaea*. The author recommends *T. melanopleura* for weed control of the ponds.

Minimum temperatures for some tilapia are as follows : *T. macrochir* - 14°C. ; *T. melanopleura* - 13°C. ; *T. mossambica* - 8°C. ; *T. sparmanni* - 7°C. *T. galilaea* constitutes 21 % of the total catch in Lake Tiberias, and *T. nilotica* and *T. zilli*, 1 %.

(139) ———— and BOTKE, F. *Tilapia mossambica* — As a Factor in Malaria 1950 Control in the Vicinity of Djakarta. *Landbouw, Buitenz.* 22 : 453-68.

T. mossambica is excellent for indirect control of malaria since it feeds on floating algae (*enteromorphae, chaetomorphae*) which give safe refuge to mosquito larvae against larvicide fish, such as *Gambusia* or *Lebistes*. Stomachs of *T. mossambica* on examination were found to be full of these algae. In the same pond, when *T. mossambica* is present, the surface is free of algae.

(140) HORA, S.L., *Handbook of Fish Culture in the Indo-Pacific Region.* (Provisional 1955 edition) FAO, Rome, Italy. Mimeo. *ii* + 264 pp.

T. mossambica attains sexual maturity at a length of 8 cm. when about 2-3 months old. It breeds throughout the year at intervals of about two months, both in fresh and brackish water with a maximum salinity of 35 p.p.m. In ponds the average weight after one year is 85 to 140 g. Tilapia spawns easily in ponds without special techniques. However, sometimes the Indonesian technique of a spawning and a fry pond is applied. In the Indonesian rice fields the association of common carp, tilapia and *Puntius* is applied with encouraging results.

(141) HUET, M. Culture of Tilapia. FAO Third International Inland Fisheries 1955 Training Center at Bogor 1955. Lecture 5.65. FAO, Rome, Italy.

Since 1924, *T. nigra* has been kept in ponds in Kenya. Since 1936, a few attempts have been made in the Belgian Congo but were only organized on a scientific basis in 1946 ; later, efforts were concentrated on *T. macrochir* and *T. melanopleura*.

Three species are now used for large scale pond culture : *T. macrochir, T. melanopleura, T. mossambica*. Experiments are advanced with *T. nigra* and *T. sparmanni*.

Several pond culture methods are described ; they differ very little with regard to species. Monosex culture is applied on a restricted scale in Kenya with *T. nigra* and tried with *T. mossambica* in Indonesia, Sarawak and Haiti. This method is unsuitable for *T. melanopleura*, which does not present sufficient size-difference between the sexes at the fry stage. The production of tilapia in semi-intensive pond culture is of about 1,000 to 2,000 kg. per ha., with a maximum of 9,000 kg. in some ponds in the Belgian Congo.

(142) LEMASSON, J. *Programme de mise en valeur des eaux continentales de l'Afrique* 1952 *occidentale française, 1952.* (*Rapport de Mission avril-juillet* 1952) Ministère de la France d'Outre-Mer, Paris 7.

A biological and statistical study is required of the natural stocks of *T. zilli* and *T. macrocephala*. There are regions where the waters are over-fished (Bas-Dahomey) and where the average length of tilapia has been reduced to less than 15 cm. Fish culture tests are being made on local species of tilapia (*T. galilaea, T. nilotica, T. zilli*).

(143) ————. *Programme de mise en valeur des eaux continentales de Madagascar,* 1953 1953. (*Rapport de Mission, mars-juin* 1953). Ministère de la France d'Outre Mer, Paris 7.

Of the three species of tilapia introduced in 1951, *T. macrochir, T. melanopleura* and *T. nigra*, only the two former species appear to be successful and tests are continuing. Breeding tests have been made of a local species, *Paratilapia polleni*, but results have been unsatisfactory since its growth is slow. Another local species of Cichlidae, *Ptychochromis betsileanus*, seems to have greater possibilities and could be raised with tilapia.

(144) ————. A propos de la pisciculture des Tilapia. *Bois For. Trop.* (45) 1956 Jan./Feb.

Comments on Djoumouna experiments described by B. Charpy (120, 121). The drawback of tilapia culture in African familial ponds is overcrowding by stunted populations. Two methods are now tried : monosex culture and the introduction of predators to feed on excess fry ; the distribution of a constant quantity of artificial food during the whole period of culture is criticized. It also seems that artificial feeding improves the growth not only directly but indirectly by developing natural food.

(145) LE MARE, D.W. Pig Rearing, Fish Farming and Vegetable Growing. *Malay.*
1952 *Agric. J., 35* : 156-66.

On a farm near Penang, Malaya, pig rearing is practised in combination with *T. mossambica* culture, with very good results. The ponds are manured with pig dung, increasing algae production, and therefore tilapia production. The aquatic plant Ipomœa grows in the ponds and provides suitable pig food.

(146) LOWE, R.H. Species of Tilapia in East African Dams, with a Key for their
1955 Identification. *E. Afric. Agric. J., 20* (4) : 256-62.

There are more than a dozen species of tilapia in dams and ponds in various parts of East Africa. The culture of these fish is still carried out rather empirically ; until more is known of the behavior of the different species it is highly advisable that new dams should be stocked only with species already in the drainage area. A possible exception to this recommendation might, however, be made in favor of the easily recognizable, weed-eating, closely related species, *T. melanopleura* and *T. zilli*. In all cases when new dams or ponds are stocked, records should be kept of the origin of the tilapia used. As regards monosex culture, with many of the East African tilapias the two sexes grow at the same rate.

(147) ————. The Fecundity of Tilapia Species. *Ibid., 21* (1) : 45-52.
1955

Fecundity has been defined as the number of young produced by an individual during its lifetime. Factors influencing fecundity are : length of breeding season, frequency of spawning during a breeding season, the number of eggs laid at a spawning, and the care taken of eggs before and after hatching. According to whether they care for their young outside or inside the mouth, tilapia can be classified as "guarders" or "brooders." Generally guarders produce many small eggs, and brooders fewer, but larger ones. Only four species are known to be guarders : *T. guidasana, T. melanopleura, T. sparmanni* and *T. zilli*. The remainder are brooders. The fecundity of guarders depends upon the number of paired fishes, whereas in brooders it is determined by the number of ripe females. In the genus Tilapia, evolution appears to have been towards a reduction in the number of eggs produced and towards the development of a brooding habit. All species of tilapia reared in ponds appear to start breeding at a very small size and to overpopulate the ponds very quickly. *T. zilli* produce a large number of eggs, and breeds in ponds freely and at a very small size. *T. zilli* stocked in dams have grown to a large size.

(148) ————. New Species of Tilapia from Lake Jipe and the Pangani River,
1955 East Africa, with Notes on the Biology of these and Lake Victoria Species Grown in Ponds. *Bull. Brit. Mus. (Nat. Hist.), 2* (12) : 347-68.

Three new species and one new sub-species of tilapia are described.

(149) MYERS, GEORGE S. Notes on the Fresh-water Fish Fauna of Middle Central
1955 America with Special Reference to Pond Culture of Tilapia. *FAO Fisheries Papers* (2).

In the author's opinion the introduction of *T. mossambica* into Central America could have a disastrous effect on local fish species. *T. mossambica* is euryhaline, omniverous and prolific, and it is impossible to foresee its effect on indigenous stocks. Some Cichlidae autochtonous to Central America may be found to be just as good for culture purposes as *T. mossambica*, which reproduces too abundantly and would certainly escape from the ponds and invade the open waters.

(150) NIGRELLI, R.F. Mortality Statistics for Specimens in the New York Aqua-
1940 rium 1939. *Zoologica, N.Y., 25.*

T. mossambica survived for seven years in pure sea water.

(151) PAN, C.L. *Growth Rate of Tilapia Fish in Egypt.* Report to FAO by Rice
1954 Production Expert. FAO, Rome, Italy. Mimeo.

Trials of tilapia culture in paddy fields in Egypt have shown that *T. nilotica* grows faster than *T. zilli*. *T. mossambica* introduction in July 1954 from Bangkok into a pond has shown interesting growth.

(152) PARENZAN, P. Esplorazione dei laghi della Fossa Galla 2. *Collezione scien-*
1941 *tifica e documentaria dell'Africa Italiana.* Ministero dell'Africa Italiana, Rome, Italy, 4.

T. zilli is present in Lakes Marguerita and Ruspoli. *T. nilotica* is present in Lakes Abaita, Sciala, Langana, Auasa.

(153) POLL, MAX. *Exploration hydrobiologique du Lac Tanganika. Poissons Cichlidae,*
1951 3 (5B). Institut royal des sciences naturelles de Belgique, Brussels.

Bionomics of 133 species of Cichlidae of Lake Tanganyika. Among them only tilapias : two widespread species, *T. melanopleura* and *T. nilotica* ; one endemic species, *T. tanganicae* ; one endemic new species, *T. karomo* Poll. *T. tanganicae* : maximum length, 38 cm. ; bottom and plankton feeder. *T. karomo* : maximum length, 30 cm. ; bottom and algae feeder.

(154) PONGSUWANA, U. Production of *Tilapia mossambica* in an Experimental
1956 Pond at Bangkhen, Thailand. IPFC Sixth Meeting, Tokyo, Japan, October 1955, *Technical Paper* No. 8. IPFC Secretariat, FAO Regional Office for Asia and the Far East, Bangkok, Thailand.

A fertile pond, highly fertilized with farm manure, planted with Ipomoea, receiving wastes and manure from pigsties and hen houses on the banks, was stocked with *T. mossambica*. Artificial food (rice, bran, peanut cake) was distributed every day. The first year, with the presence of predators (*Ophiocephalus, Clarias*) the total yield was 17.8 metric tons per ha. per annum. Of the yield 87 % was tilapia of an average weight of 150 g. The second year, with very few predators and without poultry raising, the total yeild was 14.2 metric tons. These high yields (the highest known with tilapia) demonstrate the importance of manuring and artificial feeding, also the good results given by the presence of some predators to obtain a high proportion of large tilapia.

(155) REICH, K. A Survey of Fish Breeding Research during the Period July 1951 -
1954 December 1953. *Bamidgch*, Division of Fisheries, Ministry of Agriculture, Hakirya, Israel, *6* (2). *xxi-xxix*.

When no artificial food for carp is given, but there is intensive fertilization, a mixed culture of carp and *T. galilaea* gives yields 18 to 56 % higher than culture with carp alone.

(156) SAANIN, H. Fish Culture in Reservoirs and Canals in Indonesia. Third Inter-
1955 national Fisheries Training Center, Bogor, 1955. Lecture 5.62. FAO, Rome, Italy. Mimeo.

T. mossambica is used in combination with other species to stock small fields and big reservoirs : the average stocking is about 500 fingerlings of tilapia per ha. *T. mossambica* does not give good results in canals because it swims downstream.

(157) ————. Fish Culture in Indonesia in General. *Ibid.*, Lecture 5.67.
1955

T. mossambica is cultivated alone or in combination with other species in fresh and brackish waters in Indonesia : it reaches sexual maturity at 3 ½ months (length about 9 cm.) and breeds every six weeks. The daily output of tilapia in Indonesia (open and impounded waters) is about 100 to 150 metric tons and has contributed to a considerable extent to the decrease of fish shortage in Indonesia.

(158) SARIG, S. Culture of Tilapia as Secondary Fish in Carp Ponds. *Bamidgch*, Division
1955 of Fisheries, Ministry of Agriculture, Hakirya, Israel, *7* (3) 41-45.

T. galilaea, plankton feeder, cultivated in ponds with carp, does not spawn the first year ; reaches a marketable weight of more than 100 g. during one growing season. It is necessary to stock fry of 5 to 10 g. and to raise tilapia during two carp growing seasons of 150 days. But when artificial food for carp is given, the total yield is the same in culture with carp only, and in mixed culture of carp and tilapia. Under conditions of intensive feeding, tilapia does not come into consideration as a secondary fish in the carp ponds.

(159) SCHUSTER, W.H. *Report on the Inland Fisheries of Jordan*. FAO, Rome,
1952 Italy. Mimeo.

T. galilaea and *T. nilotica* are found in Jordan.

(160) ————. *The Use of Rice Fields for Fish Culture*. International Rice Com-
1954 mission, Fourth Session, Tokyo, Japan.

There are large areas of rice fields throughout the world where fish culture could provide good yields of carp and tilapia in addition to the rice crop. If the average temperature of the water is 17°C. or more, it is possible to cultivate *T. mossambica*. At present, it is the only cultivated species recorded to feed on *Euglena sanguinea*. The algae compete with the rice plants in using nutritive elements such as nitrogen, phosphorus and potassium, and prevent the sunlight from penetrating to the bottom. Tilapia feeds on the algae and the excrement of the fish acts as fertilizer for the rice and slightly increases the yield of paddy. After a discussion of the methods in use for growing rice and carrying out fish culture simultaneously at Taiwan (Formosa) and in Indonesia, the author points out that fish culture has some drawbacks, such as greater requirements in respect of the amount and depth of water, which some varieties of rice do not tolerate. There is also the uprooting of rice seedlings by tilapia. There is still wide scope for research concerning fish culture in rice fields.

(161) ————, KESTEVEN, G.L. and COLLINS, G.E.P. Fish Farming and Inland
1954 Fishery Management in Rural Economy. *FAO Fisheries Study*, No. 3, FAO, Rome, Italy.

In Indonesia, *T. mossambica* is cultivated in rice fields with *Puntius javanicus* and common carp.

(162) SHAW, EVELYN. Two Weeks in Father's Mouth. *Nat. Hist., N.Y.*, March.
1956

Collection of photos showing tilapia development from fertilized egg to 15-day fry.

(163) TREWAVAS, E. Scientific Results of the Cambridge Expedition to East African
1933 Lakes, 1930/31 : II. The Cichlid Fishes. *J. Linn. Soc.. (Zool.)*, 38.

Taxonomy of East African species of the Cichlid family and genus Tilapia.

(164) ————. The Types of African Fishes Described by Borodin in 1931 and
1946 1936 and of Two Species Described by Boulenger in 1901. *Proc. zool. Soc. Lond.*, 116, Part II, pp. 240-46.

Rectifications of taxonomy of some cichlids, including tilapia.

(165) VAN PEL, H. *The Fisheries Industry of Fiji*, South Pacific Commission, Noumea,
1955 New Caledonia.

In 1954, 52 fingerlings of *T. mossambica* were introduced from Singapore to a pond at the Agricultural Station of Sigatoka, Fiji, by W.J.A. Payne. Large tilapia grown there serve as human food and the smaller tilapia from the pond are given as protein-containing fodder to pigs, which are also fed with the aquatic plant *Ipomoea reptans*, grown in the ponds.

(166) ————. L'élevage du Tilapia en étang, *Quarterly Bulletin*, South Pacific
1955 Commission, Noumea, New Caledonia, *5* (3) ; 81-85.

T. mossambica has just been introduced into Guam (from the Philippines) and into New Caledonia (from Fiji). Gives information about its culture.

(167) ————. Introduction of Edible Pond Fish from the Philippines. *Ibid.*,
1956 January.

In 1955, 40 *Tilapia mossambica* were introduced from the Philippines into the ponds of Port Laguerre farm school in New Caledonia.

(168) VAUGHAN-JONES. *Northern Rhodesia Game and Tsetse Control Department*,
1955 *Annual Report for the Year 1954*. Government printer, Lusaka.

T. macrochir has suffered most, presumably from the deficiency of oxygen, in Mineru Marsh after two seasons with little rainfall. In fish farming the possibility of *T. kafuensis* is investigated ; this species seems more suitable than *T. macrochir* or *T. melanopleura* for obtaining bigger fish in monosex culture.

(169) VILLADOLID, D.V. Integration of Fisheries with Fish Farming Activities in
1955 the Philippines. Eighth Session of FAO Conference. Fisheries Technical Committee. FAO, Rome, Italy. Mimeo.

T. mossambica was introduced into the Philippines in 1950. Its culture in ponds is now well established. In rivers and lakes, it apparently does not show signs of eliminating native species.

(170) ————. Integration of Fisheries and Nutrition with Farming Activities
1956 in the Philippines. Personal note.

It is strongly recommended in fish culture to provide food.

(171) WELMAN, J.B. *Preliminary Survey of the Fresh-water Fisheries of Nigeria*.
Government printer, Lagos.

T. galilaea, T. melanopleura, T. zilli, T. hendeloti, T. nilotica, T. mari are found in Nigeria. The latter three species are common. *T. zilli* can reach a length of 34 cm.

(172) YASHOUW (WIRSZUBSKI), A. Report on the Growth of *Tilapia galilaea* Artedi
1956 at the Fish Culture Research Station - Dor. *Bamidgeh*, Ministry of Agriculture, Division of Fisheries, Hakirya, Israel, *8* (2) : 31-34.

T. galilaea in ponds (alone or with carp) can have a daily growth of 0.5 to 3 g. The numerous fry produced by intensive tilapia spawning interferes with the growth of both adult tilapia and carp. Since *T. galilaea* spawns only at the beginning of the second year (size 15 cm., weight 110 g.) it might be advisable to raise tilapia by stocking fingerlings of 5 to 7 g. and to remove them from the ponds at 110 to 130 g. *T. galilaea* uses the natural food in the ponds (phyto- and zoo-plankton). An excellent growth is obtained by transferring first-spawning tilapia into ponds in autumn where carp have been removed.

(173) ZARKA, SALAH EL. Breeding Behavior of the Egyptian Cichlid Fish, *Tilapia*
1956 *zilli*. *Copeia* (2) : 112-13.

Three species of Tilapia are of primary economic importance in Egypt : *T. zilli*, *T. nilotica* and *T. galilaea*. *T. zilli* can stand a salinity as high as 29 ‰. *T. nilotica* and *T. galilaea* can live in brackish water but not in as highly saline water. *T. zilli* is not a mouth-breeder but guards the eggs and larvae.

HANDLING AND CHILLING OF FRESH FISH ON VESSELS AT SEA[1]

Progress Report from Working Group 3, FAO Interim Committee on Fish Handling and Processing, presented at the FAO Fish Processing Technologists Meeting, Rotterdam, the Netherlands, 24 to 29 June 1956.

Introduction

This report is intended to cover the scientific and industrial progress made since the FAO Meeting on Herring Technology, held in Bergen, Norway, in 1950, in the field of handling and chilling of fresh fish [2].

Many excellent scientific and popular surveys (21, 37, 40, 52, 56, 59, 70, 71, 72, 81, 86, 92, 94, 95, 96, 98, 100, 101, 103) have been published during this period, and leaflets (38, 47, 54, 58, 82, 87) for industry and trade been issued in various countries. The author did not have access to Russian and Japanese publications, and these are not included in the references, which are intended as a guide to the reader, and not as a comprehensive bibliography.

It has not been possible to report here the important work carried out in the last 5 to 10 years on the microbiology of fresh fish, mainly at British and Canadian research stations, or on the interesting work done on the bacteriology and keeping quality of shrimps.

Since 1950, the field of quality assessment has been explored more fervently, if possible, than ever before, with special emphasis in some laboratories on taste panel work. It is interesting to note that while organoleptic methods in the earlier days of fishery work were considered deceptive or, at best, only in very rough approximation to the condition of the fish, taste panel results have lately become almost generally acknowledged as the real basis of all quality work. Incidentally, this does not apply only to research on fish.

Experimental Work

Influence of Temperatures on Keeping Time

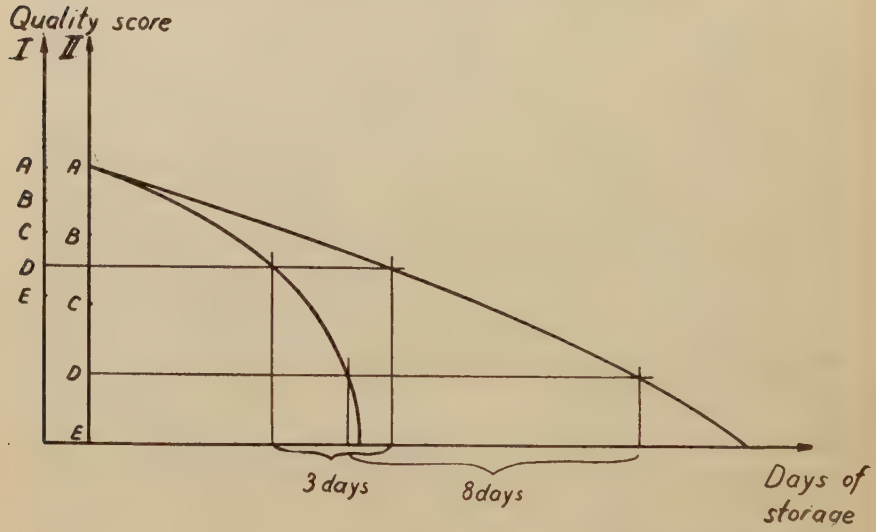
At the time of the Bergen meeting, the first news from Canada of quantitative experiments on the relative keeping times of fresh cod and haddock at various temperatures between 32° and 50° F. (0° and 10° C.), had just been published (43, 44, 61). The results, which showed the overwhelming influence of the temperature factor, were in agreement with earlier experiments with fish spoiling

[1] by F. Bramsnaes, Technological Laboratory, Ministry of Fisheries, Copenhagen, Denmark. For Part I of this Report, "The Preservation of 'Wet' Fish," see *FAO Fisheries Bulletin, 7* (2): 49-65.

[2] see *FAO Fisheries Bulletin 3* (6): 144-45; and *The Technology of Herring Utilization*, Report of the FAO Meeting on Herring Technology, Bergen, Norway, September 1950, published by the Director of Fisheries, Bergen, Norway, 1953. Price: N. Kr. 14.00.

bacteria. Later, these findings were confirmed elsewhere for cod and plaice by means of fair size taste panels (2. 33, 96). These organoleptic tests have not always shown the sharp rise in Q_{10} with decreasing temperatures which were found previously by watching the growth of bacteria or trimethylamine content. The important conclusion reached as a result of the experiments with demersal fish from the North Atlantic and adjacent waters is that the keeping time within the temperature interval of 32° to 41° F. (0° to 5° C.), which is the main interval for storage of fresh fish in the industry, can be expected to increase by 1 to 2 days per each degree of temperature lowering. The increase depends on where the end-point for the keeping time is fixed (*see* diagram).

It remains to be proved whether the relation found between temperature and keeping time is valid for fish in other climates.



The two curves show the decrease in quality for two lots of fish treated differently, determined by two taste panels. The two panels both reject the fish at the level of "stale"; but one panel is very strict in its judgement (score scale I) while the other panel is less critical (score scale II). Panel I, therefore, finds 3 days difference, and Panel II 8 days difference in the keeping quality between the two lots of fish.

With regard to pelagic fish, especially herring, the reader is referred to the detailed paper (97) presented in Bergen, and to the discussion which took place at the Meeting. While, with demersal fish, the bacterial spoilage is by far the most decisive factor, autolysis and possibly chemical changes in the fat sometimes play an important role in the deterioration of pelagic fish. The digestion of the belly walls in feeding summer fish can proceed at a rate out of all proportion to that of the other spoilage processes.

Handling of Fish at Sea

Research work during the 'thirties, especially in Great Britain, showed that the factors which chiefly influence the quality of fish as treated aboard trawlers are: temperature, amount of ice, and care in handling, gutting, cleaning and stowing. However, the quantitative data have hitherto been too restricted to prove convincingly the relative importance of each of these factors or to attempt to evaluate at all exactly the effect of altering any particular feature of current practice.

Since 1950, most research stations have been concerned with these problems, and there is today a much clearer picture regarding the practices on board the fishing boat.

Exposure on Deck

It has proved important not to leave fish exposed to air on the deck longer than absolutely necessary. Well treated white fish landed 14 days after catching can still be acceptable — although no longer fresh — but they can also be inedible owing to delay in chilling with ice (96). Experiments on board large British trawlers showed that, if gutted, washed white fish were exposed to temperatures of from 41° to 44° F. (5° to 7° C.) for 18 to 20 hours, as may well happen before packing in ice, storage life is reduced on an average by 2 days, as compared with controls, iced immediately after catching (11). Similar results, even if not so convincing, have come from Canadian schooners (50). In a laboratory experiment, white fish were exposed to a temperature of 41°F. for 22 hours immediately after catching, gutting and washing, then stored in crushed ice for 8 days ; the temperature was allowed to rise gradually during the next 2 days from 32° to 41°F. It was shown that the storage life of the fish was reduced from 18 to 13 days (11).

Other tests have shown that even a delay of 3 hours in icing in summer (59° to 64°F. or 15° to 18°C.) may suffice to have a noticeable effect on the quality of white fish 6 to 8 days after catching (8, 47).

Several actual measurements have proved that fish lying on the deck rapidly reach the temperature of the surrounding air or, in the sun, even higher temperatures. In many cases the fish already have a high temperature from the water. Finally, measurements have shown that even in cold weather the temperature in the fish, influenced by the post mortem (*rigor*) production of heat, may remain at a fairly high level (32.9° to 41°F. or 4° to 5°C.) for many hours, in spite of a fall in the air temperature from 37.4° to 34.9°F. (3° to 1.6°C.) (4).

Gutting of Fish

It is a general experience that the keeping quality of white fish decreases if they are not gutted before stowage in ice. The bad effect of leaving the entrails in the fish may primarily be autolytic,

as it has been found that spoilage products which are formed in the intestines of haddock, do not diffuse out into the flesh while the intestines are intact (93). In the case of gutted fish, these spoilage products are formed rapidly in the belly cavity (63). The flesh of gutted fish may, therefore, have a higher content of spoilage products than similar ungutted fish, and it is thus proposed that haddock be stored in the round state. In very short storage, this is probably a good practice. It may also apply to flounder (49), provided that the fish iced properly immediately after catching, kept at 32°F. and consumed or filleted within 2 to 3 days. It was found that fillets from ungutted flounders, which had not been stored for more than 4 or 5 days, did not spoil more readily than similar fillets from gutted fish.

It would save a great deal of time, also provide an opportunity for the fish to be packed in ice more quickly, if off-shore and near-shore fishermen could store their fish directly in the hold after washing, but for many reasons it would not be advisable to let the fishermen do so yet. One reason is that they have not yet learned to ice fish sufficiently and quickly enough ; another that the above-mentioned experimental results may turn out differently when the stomach contents are more or less " active, " as was the case during these experiments.

Experiments with mackerel proved that there was no appreciable difference between gutted and ungutted fish which had been iced for 6 days. However, the quality of the eviscerated fish was best at 41°F. (41). The above remarks on the digestive power of the stomach contents also apply to these experiments. It is generally found that feeding summer mackerel would not even keep 6 days in ice.

Washing on Board

Many data have been collected on the effect of washing the fish after gutting on board. Recent experiments with cod and haddock at sea, including fish in ice in the holds from 1 to 8 days, indicated that if the fish are properly and carefully gutted, i. e., the intestines are removed whole, there is very little added advantage in washing the fish at sea (47, 50). These numerous experiments showed both a better and a poorer keeping quality in washed fish, as compared with unwashed fish (85).

Other workers have found that washing, as practised on ships, has little effect on the subsequent quality. The skin of the washed fish was found to have, if anything, a bacterial load bigger than that of the unwashed fish (31). Others again have found that the washing of headed and gutted hake keeps the fish in prime quality for 9 to 10 days instead of only 7 to 8 days for unwashed controls (22).

Experiments on a trawler have shown that pollack, which had been carefully and individually eviscerated and washed, kept better

than fish which had been gutted and washed in the normal way (81). Under the present practice, however, it is difficult both to gut and wash very thoroughly, except on small fishingcraft with a limited catch.

It was stated some years ago that rough treatment on the deck, i.e., walking and trampling on the fish, did not impair the keeping quality (50). The same workers later concluded that fillets from bruised and crushed fish, which had been kept in ice for 6 to 7 days, spoiled much faster than controls which had been carefully handled (52).

Ways of Chilling

After handling on the deck, the fish should be cooled quickly and as near the freezing point of the flesh as possible, and then kept at this temperature. Available means of cooling are air, ice and chilled water.

Air, however, should not be used for chilling fish because the rate of cooling in this medium is very slow. Moreover, when chilled fish, which have not been iced, are compared with iced fish, the temperature in both being the same, it is found that the iced fish keep from 2 to 3 days longer. This phenomenon, which can be measured by a taste panel, by bacterial counts or by development of chemical spoilage products, is probably due to melting water washing away some of the bacteria and some of the badly tasting ingredients (23, 29, 33, 47).

Ice will cool even warm fish to about 32° to 31°F. (0° to -0.6°C.) in a few hours, if properly used and in sufficient quantity (6, 15, 58, 85). On the other hand, if insufficient ice is applied or if the ice is not mixed thoroughly with the fish, they will either reach these temperatures very slowly or not at all (16, 51, 85). In one case, it took 3 days for the temperature in fish stowed in 15-inch (38 cm.) thick layers with ice between to cool to 32°F., and in many cases it never reached this level. When fish were stowed in layers only 3 inches (7.6 cm.) thick, with 1½ inch (3.8 cm.) layers of ice in between, 32°F. was reached in 7 hours (85).

Experiments in fish holds confirm what is known from practical experience, namely, that it is not enough merely to cool the fish. They should also be stowed and the ice deployed in such a way that it can absorb the heat from outside. If this is not done, the temperature in the fish lying close to the ship's side will rise dangerously. In many trawler holds measurements have shown rises up to 41°F. or higher, especially if the fish have been placed close to the deck or the ship's side in uninsulated holds (3, 58, 85). In one case the temperature rose to 51.8°F. (11°C.) during the last 4 to 6 days of the voyage (10).

In this connection, it is learnt from calorimetric measurements of chopped haddock muscle packed in ice that fish generates — owing to bacterial and cheminal processes — from 1 to 3 calories

per gram of fish every 24 hours. This corresponds to 25 tons of ice on a North Atlantic trawler voyage (32). It would be interesting to have the figures for the whole fish in ice.

Losses of Protein in Stowage

The ice cools because it melts. The melting water dissolves some of the salts, soluble proteins, etc. in the fish. It has been shown that a high percentage of the protein and more than half of some of the flavoring constituents might be washed out as a result of melting ice running over the lowest part of the stowed fish for 12 days (62). Previous American findings describe weight losses averaging 8%. Large-scale experiments have since then been carried out on British distant water trawlers. The results indicate that the loss of weight increases as the fish get staler. Cod kept in ice for 16 to 18 days at the bottom of the hold lost 10 to 13% in weight, and haddock somewhat more. Fish at the top of the hold lost less. The average for first-caught fish was 8 to 9% (57). A formula for these losses has been suggested (18). In comparison, boxed fish sometimes showed slight gains (18/57), although also suffering a loss in protein, which was counter-balanced by an intake of water (9).

Storage in bulk affects mainly the appearance and not significantly the keeping quality. Such fish may look from 2 to 4 days older than similarly treated boxed fish (3).

Storage Limits

During ice storage in holds a progressive loss of freshness, followed by spoilage, takes place, although slowly, even at 32°F. Chilling by ice as a means of preservation has definite limitations. Even well treated cod and haddock will not remain reasonably fresh for more than 10 to 12 days (58). Flat fishes will generally keep a few days more, herring and mackerel a few days less. From the Bergen Meeting it was evident that the keeping quality of herring is highly dependent on the season and on the type of herring.

Bilgy Odors

As regards white fish, a strong odor sometimes develops before the fish otherwise become putrid. This has been described as a " bilgy " odor. It is attributed to bacteria coming from the intestines of the fish and growing under anaerobic conditions, mostly where the fish lie against a wooden board. But it may also develop when the fish are pressed tightly together (46).

The widespread occurrence of " bilgy " fish in Canada, has led to the interesting experiment with fish lying close to pound boards or inner lining of various materials. Rough, unpainted wood — also worn, painted boards — appeared to be a very serious source of contamination. Newly painted or varnished boards

and aluminum surfaces gave practically no " bilgy " odors. It is claimed that painted wooden surfaces will be " worn " after a few voyages, and aluminum lining is therefore essential (83). Another solution suggested is the installation of heavy wire screens against the side of the hold to retain the ice and to prevent the fish from contacting the wooden boards (82). Many fishermen would not favor this, feeling that the desired downward sliding of the mixture of fish and ice during the voyage would be prevented. Practical experience in Europe has proved that prime quality fish can be landed from wooden-lined boats when plenty of ice is used — it may be that an even distribution of ample quantities of ice throughout the catch prevents anaerobic conditions. In North Europe, it is customary to paint the holds in boats about once a year.

Functions of Ice

Ice has three functions, namely, to cool the fish ; to keep the fish cool, and to establish aerobic conditions in the fish holds, as well as in the containers for fresh fish. Incidentally, there is a " leaching " factor, which causes not only the removal of undesirable odors in old fish, but also the removal of desirable flavors in fresh fish.

Ice should be clean. Evidence that this is not always the case has been published, according to which up to 5 million bacteria per gram of ice were found in ice in boats preparing to leave port. The ice was presumably " old " (53). In many places it is the normal practice, on landing, to remove ice which has not been used. The question of contamination of fish by ice needs further investigation.

Salt Water Ice

A temperature of about 30°F. (−1°C.) is probably the best for the storage of fresh fish. As this temperature is often difficult to obtain with ordinary water ice, it has been suggested than salt water ice (65, 78, 79, 107), or a chilled weak brine or chilled sea water (13, 29, 73, 76, 77), be used. Production of salt water ice on a commercial scale is possible (7, 14, 65). Apart from the advantage of ice being produced where water is not available in sufficient quantities, it is claimed that salt water ice is less injurious to fish because its softness, that it does not cake like normal water ice, and that it secures a lower temperature in the fish. Several experiments indicate a better keeping quality of fish in such ice, as compared with normal ice (26, 78, 80, 107). Further experiments would be of interest. The ice used contained 1 to 2% salt, and temperatures of 28.4° to 21.2°F. (−2 to −6°C.) were measured in the ice. The salt disappears with the melting water during the storage of the fish, and the final temperature of the ice corresponds to that of normal water ice (29).

Storage in Chilled Sea Water

On the Canadian west coast, interest is focussed on storage of fish on board, in tanks filled with chilled sea water kept at 29° to 30°F. (–1.7° to –1.1°C.). Salmon stored in this way from 8 to 19 days were preferred to normally iced fish. Examples of practical installation have been given (68, 69). Nothing has as yet been published regarding the behavior of the boats in rough weather.

Later experiments have proved that fish stored in sea water have a much better appearance normally than iced fish. Bacteriological examinations of fish from the tanks have shown both higher and lower counts as compared with iced fish (102). Laboratory experiments showed that salmon stored in sea water lose less protein than if stored in ice, and that fish stored in sea water maintain their weight while those stored in ice lose weight (36). As mentioned earlier, experience with stowage of white fish in ice showed loss of weight when the fish are under heavy pressure but gain in weight when in boxes.

More evidence is needed concerning flavor after long storage. The flavor in fish stored in 32°F. tap water has been found inferior to that of fish stored in ice (23).

Loss of nitrogen from gutted fish would indicate that, when using chilled brine or sea water, storage of round fish is to be preferred (36).

Preservatives

There is a continued interest in preservatives and disinfectants, which may be used for extending the keeping quality of fish. Many publications on the subject have appeared, and only a few can be mentioned here. The reader is also referred to several detailed surveys (92, 98, 104,).

Present knowledge on the preserving effect of nitrite in concentrations not harmful to humans has been confirmed, partly by the continued commercial use of this additive in Canada, and partly by further experiments with both fillets and whole fish (18, 25, 45, 89, 90, 99). More is known about the limitations in the use of nitrite. It may lead to discoloration and rancidity in certain species of fish, especially fatty fishes. A slight, reddish discoloration has also been found in flat fishes and in cod fillets which were subsequently frozen (20, 25, 35, 106). Nitrite may not always have an affect great enough to justify commercial use (35) and if nitrite ice is stored above 32°F. in a fish hold, for instance, some time before it is used, the nitrite will quickly disappear with the melting water, and no difference in keeping quality is seen between nitrite-treated fish and controls. In such cases a dip in nitrite solution is to be preferred (35, 48). It has lately been established that a 2-minute dip in a 1% concentration can be used for medium-sized and large-

sized cod and haddock. The residue in the flesh 24 hours later does not exceed the sanitary limit (200 p.p.m.) (48). Solutions of 0.2% have hitherto been common.

Among the antibiotics, aureomycin and terramycin have proved effective (12, 23, 28, 31, 34, 64, 105, 106). Some of the results come from model experiments, others from pilot scale storage of fish in ice or chilled sea water. Most work has been done on aureomycin in ice containing 1 to 7 p.p.m. of this antibiotic. An extended preservation time of up to 7 to 10 days has been observed. In other cases the aureomycin-treated fish kept only a few days longer than the control (23, 34). This discrepancy may partly be explained by the choice of different end-points for the keeping time (*see* diagram p. 26).

It has also been shown that " dip " in a 1 to 2 p.p.m. solution of aureomycin or terramycin has a prolonging effect on the keeping quality. Finally, experiments have been carried out with fish in chilled sea water containing 1 p.p.m. aureomycin, where the bacterial counts were nil compared with heavy loads on controls kept in ordinary chilled sea water (67).

This striking evidence has led to large-scale experiments of which no results have as yet been published.

It has been a problem with antibiotic ices and other preservative-containing ices, to obtain an even distribution of the chemical. This difficulty has been overcome by the addition of preparations of carrageen or carboxymethyl-cellulose (39, 66).

Health authorities, with one exception, have not, as yet, approved the use of antibiotics in food. If permission is given, it will most likely be limited to a few only[3].

Experiments have been carried out with many other preservatives. Formaldehyde and sulphonamides were found to have a noticeable preserving effect when mixed with ice (91). Evidence is conflicting regarding foromycin, a formaldehyde derivative (19, 74). Hydrochloric acid, citric acid, malonic acid, monobromine, acetic acid and quarternary ammonium products have again proved negative (16). Experiments with carbondioxide have reached no practical solution (5, 10).

Progress in the Industry

While advances in experimental work since the Bergen Meeting have been quite spectacular, progress in the practical handling of fish is much less evident. It would, however, be wrong to conclude that the men in the fishing industry are not alert to progress, or unwilling to utilize the advances made in research. On the contrary, the fishermen and boat-owners give the impression that they are very anxious, within their financial possibilities, to improve

[3] In September 1956, Canada legalized the use of chlortetracycline in the preservation of chilled fish, provided that the residual at the time of sale does not exceed five parts per million, and provided that the preservative is declared on the label.

the quality of the fish. And practical experience gained by the industry itself, combined with the results of scientific research mainly concerned with the important temperature factor, is steadily improving the quality of fish offered to the consumer. In some countries there has been a considerable increase in the amount of ice used for fish.

Collaboration between research and industry is becoming closer, and a bigger part of the experimental work is being done on the vessels, on the quay and in the plants.

Washing Fish on Deck

During the last 5 years there have been 2 innovations. One, to be found on a number of British trawlers, is a washing tank, which is fitted near the hatch. It simplifies washing and facilitates a steady flow of fish to the hold (1). The deck-flume, devised in South Africa, has the same advantages ; the result here has been to halve the time between the release of the cod end and the lowering of the fish into the hold (27). The washing efficiency of these apparatuses has not been scientifically evaluated, but it is certain that they speed up handling on deck.

Hold Construction

Lining of holds. The advantages of a light alloy (aluminum) lining to fish holds, much advertized some years ago, have not led to extended use of this material. The disadvantages of such a lining are primarily its high cost, but it is also claimed that aluminum lining does not resist rough handling as well as wood. It is, however, a fact that several boats, fitted from 5 to 7 years ago, with light alloy lining are neither much damaged nor corroded. The hygienic properties of aluminum are also an advantage and the cost of cleaning is less than that of a wooden hold. In Canada, it has been found that, when using aluminum lining, less ice is needed for stowing ; in an insulated hold, lined with aluminum, it is unnecessary to avoid contact between lining and fish, while in an insulated, wooden-lined hold, to avoid " bilgy " fish, it is necessary to bank a layer of ice against the pen surface (82). There may also be some saving due to the difference in weight between wooden lining plus wooden boards as compared with a similar outfit of light metal. No generalizations can be formed ; separate calculations for each vessel should be made.

Summing up, there is an evident desire to improve the wooden lining now in use. On the other hand, information is still lacking regarding the economical advantages of aluminum and to what extent these counterbalance the extra costs of installation. In the meantime, those who prefer wood regard with interest the experiments aimed at improvement of the paints used.

Insulation. It is difficult to establish to what extent insulation of fish holds is used, compared with 6 to 7 years ago. In some countries, for instance Portugal and South Africa, there has been an increasing use of insulation in large trawlers (55, 60). In general, it can be said that insulated fish holds are used extensively in large steel trawlers, many companies regarding them as a necessity. The need for insulation is evident when it is a question of high water temperatures, but many people also consider it useful in colder climates. In this connection it is worth mentioning the British experiments on distant water trawlers, which showed that it is possible to land well iced fish from uninsulated holds ; sufficient ice should be placed against the side walls and the deck. In view of this, and because ice is a cheap commodity, some boat-owners consider insulation unnecessary. Also the cost of repair is lower in an uninsulated boat.

The insulation material most commonly used is still cork, cemented to the hull of the ship, in some cases with a small air space between the insulation and the inner lining in order to give the juices, which may penetrate from the fish room, a chance to escape. Insulating materials of expanded plastics are gaining on the older types of material. They are water-resistant and light. Alfol and glass wool have also been used in recent trawler construction. When glass wool is used, an impervious layer is fitted between the wood and the insulation.

In double-wooden boats, particularly small boats, there is rarely any insulation. It is generally considered difficult to insulate at a fair price the side walls and the deck because of the danger of rot in the wood. This matter needs further investigation. It is possible that a solution can be found by using the newer water-resistant types of insulation. The good insulating properties of the wood itself provide another reason for not insulating a wooden boat.

Mechanical refrigeration. It has become more common during the last few years to install mechanical refrigeration in fish rooms in the form of grids or coils immediately under the deck. The total number of boats equipped in this way is still, however, insignificant.

When, in 1936, three new U.S. trawlers were fitted with refrigeration, it was described as " absolute elimination of second and lower grade fish — longer days at sea, " etc. Today, all trawler owners know that it is the proper icing of the fish, maybe in connection with the use of insulation, that produces first quality fish and decides how many days within the range of possibility the fish will keep.

The main functions of underdeck refrigeration are to cool empty fish rooms, to keep the ice in a crisp, handy condition and to cool all shelves and fitting before the stowing of the fish. Grids or coils can also keep the air cool above " shelved " fish. The grids cannot, however, influence the temperature of the general mass of fish (58).

Some fishing boats need to be very versatile and mechanical refrigeration maintaining the ice in the hold during search for fish is here considered an advantage (42).

A series of reasons — they could even be called disadvantages — have given mechanical refrigeration a bad reputation.

(*a*) The temperature of the air in the hold is not uniform. Placing of thermostats or thermometers is therefore difficult (55, 58, 75, 82). Wrongly placed, they might cause some of the fish to freeze.

(*b*) The temperature of the air must be high enough to cause a reasonable melting of ice while the fish are packed in ice. If not, the fish will keep less well than in a well iced, non-refrigerated hold (58, 88). This is due to the "leaching" effect of the ice. In fact, the higher the temperature of the hold, the quicker the fish are cooled, and the better the keeping quality (30).

(*c*) Frosting of coils is a serious problem. If defrosting is neglected the effectiveness of refrigeration is lessened. This causes drip from the coils during unloading and, in some cases, workers have refused to unload such boats.

(*d*) Care should be taken in selecting the right refrigeration machinery adapted to the extra hard conditions on board fishing vessels.

It is important that a fishing vessel has as little equipment as possible on board which requires attention or which is not absolutely necessary. Mechanical refrigeration would belong to this group. The optimum condition of fish preservation is one that keeps the temperature of the air low without preventing the ice from melting, i.e., about 41°F. This is easily obtained without refrigeration in an insulated fish hold.

Jacketed fish holds. In Western Germany, boats have been built with jacketed fish holds, where refrigerated air is circulated so that it completely envelopes the fish hold (88). In Canada, where much interesting work has been carried out, several boats have been experimentally fitted in this way. In addition, these holds have been insulated with cork or expanded plastic material. Finally, the inner lining has been covered with aluminum. It was found that seams could not be made fully watertight and welding was, therefore, preferred in the last 2 boats where watertightness was essential. The power for the compressor is furnished by a Diesel generator (82).

Comparisons of quality of landings from these Canadian jacketed refrigerated boats, with those of normal wooden-lined, non-refrigerated boats, showed that the fish from the latter were definitely inferior.

To reduce the cost of installing the jacket, metal fish pens of unit construction have been designed. A pen has been installed and is now being tested under commercial conditions.

A detailed estimation of cost of construction and maintenance of a wooden fish hold, in comparison with a "unit pen" hold, has been made (82, 84).

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AN ANNUAL BIBLIOGRAPHY FOR MARINE SCIENCE

The recent publication of the *Bibliographia Oceanographica* for 1950 is another step towards the ideal provision of a comprehensive and complete bibliographic listing service for research workers and others concerned with the study of the sea in all its aspects, but particularly with marine fisheries.

Volumes of the *Bibliographia* for the years 1928-49 were published in a continuous series by the Italian Delegation to the International Commission for the Scientific Exploration of the Mediterranean Sea. In past volumes, until 1942, the titles of the entries were translated into Latin and annotations, usually in Italian and occasionally in French, English or German, according to the language of the author, were made to indicate the contents of each paper listed. The number of entries sometimes reached 3,000 annually ; they were arranged by broad subject classes and indexed by authors (in some earlier volumes, by species and subjects also). After the war the lists were published without Latin translations of the titles but annotations. The volumes for 1943 to 1949 were published with the help of the Italian National Research Council.

The Biology Branch of the FAO Fisheries Division is now assisting the editors of the *Bibliographia Oceanographica* to prepare annotations in English and to extend coverage of the literature, especially that dealing with studies relevant to fisheries. More than 600 serial publications are now being searched systematically for titles, and annotated as far as possible.

From the present volume onwards, the *Bibliographia Oceanographica* will be published in a bi-lingual form (Italian and English). The entries will be arranged under separate headings corresponding to the main numbers of the Decimal Classification for Fisheries, which is being developed by the Fisheries Division (see *FAO Fisheries Bulletin* VIII (2) : 91-94 ; IX (2) : 98-100).

In the 1950 volume there is an author index and it is hoped in later volumes to provide also species and geographical indexes. At the same time all references are being entered on punched cards that can be needle-sorted to group references according to any desired breakdown by author, date, species, place or subject, or combination of these. The index system is being extended to cover publications relevant to both marine and inland fisheries.

During the war years, publication fell far in arrears, but by special efforts and with the co-operation of FAO, the editors are now making progress in bringing the *Bibliographia* up-to-date. It is planned to achieve this by publishing two volumes each year for four years : thus 1951-55 in 1957, 1952-56 in 1958.

Copies of the 1950 volume may be obtained directly from the Consiglio Nazionale Ricerche, Piazzale delle Scienze, Rome, Italy. Details of the volumes from previous years that are still available may be obtained from the same address.

Fisheries Division Activities

Dr. D.B. Finn, Director of the Fisheries Division, left Headquarters on 16 November, 1956, on an extended tour of Latin America. He first visited Santiago, Chile, to participate in the FAO Latin American Regional Conference, 19 to 30 November, and then departed for Brazil, Uruguay, Venezuela, Colombia, Panama, Guatemala and Mexico, to study the state and progress of the various FAO fisheries projects in these countries, and to confer with the fisheries authorities there.

Dr. Cecil Miles, FAO Regional Fisheries Officer for Latin America, Santiago, visited Panama, Ecuador, Colombia and Peru during October, to meet the fisheries people and technical assistance experts in these countries. After attending the Regional Conference, he left Santiago again at the end of November to accompany Dr. Finn on his tour as far as Mexico City.

Personnel

Dr. T.J. Job, of India, formerly FAO Assistant Regional Fisheries Officer in Bangkok, Thailand, has been transferred to Headquarters, Rome, and is now working in the Biology Branch. His post in Bangkok has been taken by Dr. M.R. Khan of Pakistan.

Mr. Y. Miyake, of Japan, previously of the Agricultural Economics Bureau, Ministry of Agriculture and Forestry, Tokyo, has joined the Fisheries Economics and Statistics Branch.

Regional International Organizations

One of the functions of FAO is to encourage international co-operation in all fields concerned with the increased production of food and, in pursuance of this policy, FAO has supported and encouraged the establishment of regional international organizations, such as the Indo-Pacific Fisheries Council (IPFC), and the General Fisheries Council for the Mediterranean (GFCM).

FAO supports both the IPFC and the GFCM financially and provides their secretariats. Officers of the Fisheries Division are continuously engaged on work for these Councils and with promoting the programs of work of the technical committees on them.

General Fisheries Council for the Mediterranean (GFCM)

The 4th Meeting of the GFCM, held in Istanbul from 17 to 22 September 1956, by invitation of the Government of Turkey, was attended by some 80 delegates representing 15 countries and 7 international organizations. Prof. Umberto D'Ancona of the University of Padua, Italy, was in the chair.

Mr. M.J. Girard, FAO Regional Fisheries Officer for Europe and the Near East, and Secretary of the GFCM, was in charge of arrangements for the Meeting. Other FAO officers who attended were Dr. Ernest Hess, Chief, Technology Branch; Mr. Colin Beever, Fisheries Economics and Statistics Branch; Mr. Sidney Holt, Biology Branch and Mr. Cedric Day, Information Officer.

The Meeting decided that the general programs of work of the five technical committees adopted at the 3rd Session (*FAO Fisheries Bulletin*, VIII (1) : 41-45) should be continued.

The programs of work for 1956/57 are summarized below; the names in brackets are of the special rapporteurs.

EXPLORATION COMMITTEE

1. A. *Clupeidae* (M. Gómez Larrañeta, Spain)

   (*a*) Identification of stocks by classical methods (vertebral number, etc.) and trial application of new techniques;
   (*b*) determination of the present state of the stocks;
   (*c*) determination of the place, time and intensity of spawning;
   (*d*) quantitative plankton methods.

   B. *Tunas* (G. Belloc, Monaco)

   (*a*) Bathymetric and geographical distribution;
   (*b*) nutrition and sexual state;
   (*c*) migrations.

   C. *Edible Crustaceans* (Dr. R. Dieuzeide, France)

   (*a*) Nomenclature of the various species in each country;
   (*b*) ecology of these species.

   D. *Study of Trawling Grounds* (Prof. G. Bini, Italy)

   (*a*) Determination for each country of trawlable grounds;
   (*b*) indication of their present production;
   (*c*) biological research on the main species.

2. *Recommendations and General Resolutions*

   A. *Clupeidae*. The Council requested the Secretariat to call the attention of the experts working on Clupeidae to working document 20/1, (Standardization of Methods of Measurement and Observation of Clupeidae), and to solicit their opinions.

   B. *Tunas*. Member countries are invited to undertake a marking experiment, especially on *Thunnus thynnus*.

   C. *Edible crustaceans*. The Council recommends that the study of mesoabyssal Peneidae be intensified.

D. *Study of trawling grounds.* It is recommended that the schedule of information mentioned in working paper 20/4 (Trawling Grounds) be completed, and that a short and precise report on the present knowledge concerning the abundance and bionomics of the main exploited population of the demersal species be submitted to the next meeting, together with statistics of the catches and estimates of the fishing effort.

PRODUCTION COMMITTEE

1. A. *Trawling* (Z. Fried, Israel)

The study of a new type of trawling has led FAO to propose a study of the efficiency of trawl nets utilized in the Mediterranean. The Israeli, Italian and Jugoslav delegations declared their readiness to put a trawler with equipment and crew at the disposal of the GFCM, in order to make it possible to carry out such a program. Research will also be made on the selectivity and the size of the meshes of the trawl.

B. *Methods and Gear for the Catching of Tunas and Shrimps* (D. Iyigüngör, Turkey)

Contacts will be made to study the development of tuna and shrimp fisheries by the use of appropriate gear, and to investigate the biology of the stocks.

C. *Protection of the Hulls of Boats and Preservation of Nets* (M.B. Komarowsky, Israel)

The study concerning the fouling of hulls and the preservation of nets will be continued.

D. *Classification of Boats and Fishing Gear* (L. Krstinič, Yugoslavia)

The classification proposed by Dr. T. Soljan has been accepted. Governments are requested to complete the classification and establish lists of names corresponding to the classification.

E. *Vocational Training of Fishermen* (Cdr. G. Bonamico, Italy)

The documentation already assembled will be completed to enable the special rapporteur to prepare a program for the vocational training of fishermen.

F. *Working Conditions and Security of Fishermen* (Dr. R. Cusmai, Italy)

In view of the changes which occurred last year, the Secretariat has been invited to continue collecting data on the working conditions and security of fishermen.

G. *Fisheries Administration.*

A working paper is to be published on this subject.

2. *Recommendations and General Resolutions*

A. Technical papers No. 27 (Sur la régénération des fonds de pêche du Levant espagnol) and No. 36 (Savings Gear Experiments with Trawl Nets in Israeli Waters) will be sent to the meeting to be held in Lisbon, Portugal, in May 1957, and organized jointly by ICES, ICNAF and FAO, with a view to studying and assembling data on the selectivity and catching power of fishing gear. The GFCM should be represented at the meeting.

B. It was considered that the GFCM should deal with problems related to propaganda for fish consumption. It is recommended that FAO contact various governments in order to collect information concerning methods and means used (radio, posters, etc.), before the GFCM carry out this operation.

C. In view of the interest taken in conducting research concerning improvements in :

(*a*) construction of the trawl used at present ;
(*b*) selectivity by the determination of the optimum mesh size ;
(*c*) the kind of material used for making nets

it is recommended that a study be undertaken by FAO with a view to improving the efficiency of the Mediterranean trawl, such research to be undertaken on the basis of the underwater studies made by Dr. Perlmutter of the American Mission in Israel.

D. It is recommended that governments make the necessary budget provisions to send delegates to the FAO Fishing Gear Gongress, Hamburg, Western Germany, October 1957, and it is suggested to the organizer of the Congress that a special section be established for the study of Mediterranean gear. The GFCM should be represented at the Congress.

UTILIZATION COMMITTEE

A. *Fish Packing for Transportation* (Dr. R. Dieuzeide, France)

B. *Fish Meal* (N. Ozisik, Turkey)

C. *Semi-preserves* (D. Rémy, France),

INLAND WATERS COMMITTEE

1. A. *Organization of Fish Administration for Inland Waters in the Mediterranean Countries*

(*a*) Research institutes and laboratories ;
(*b*) services and organizations concerned ;
(*c*) importance of the budget allocated ;
(*d*) essential points of regulations.

B. *Fish Culture Techniques* (S. Tal, Israel)

(*a*) *Carp culture.* Action to be taken in view of increasing carp consumption in Mediterranean countries.

(*b*) *Valliculture.* Completion of the survey on saline lagoons (Prof. U. D'Ancona, Italy).

— culture and catching methods ; devices to renew the water ; artifical feeding and reproduction of grey mullet.

(*c*) *Barrage lakes.* Completion of survey (P. Vivier, France).

(*d*) *Salmon culture.* Production of plankton for the feeding of trout (M. Svetina,. Yugoslavia).

C. *Water Pollution. General Process for Purifying Organic Residual Waters* (C. Maldura, Italy).

D. *Economic Matters Relating to Fish Culture* (R. Charpy, France)

Evaluations of the production of inland waters and of the consumption of the fish caught in those waters in various Mediterranean countries.

2. *Recommendations and General Resolutions*

A. *Pollution.* Working Paper 23/1 (Pollution of Water), prepared by C. Maldura and P. Vivier, concerning the residual waters of sugar refineries, should be published.

B. *Valliculture.* Mediterranean countries with saline lagoons are invited to furnish precise documentation.

C. *Carp culture.* It would be of very great interest for documentation to be exchanged between the Mediterranean countries on carp diseases also more generally on fish diseases.

D. *Barrage lakes.* The GFCM will give special attention to the problem of fisheries in barrage lakes.

E. *Salmon culture.* The attention of the GFCM has been called to the importance of the problems regarding trout, in relation to the development of sport fishing.

Economics and Statistics Committee

1. A. *Preparation of Catalogues - Fish, Mollusks and Crustaceans*

The preparation of these catalogues will be continued.

The *Atlas des poissons des Côtes algériennes*, published by Dr. R. Dieuzeide, can be used as a basis for a complete catalogue of fish names. Special rapporteurs : Prof. G. Bini and Prof. E. Tortonese (fish names) ; Messrs. Bacci and Mars (Italy) (mollusks) ; R. Dieuzeide (France) (crustaceans).

B. *Fisheries Statistics in the Mediterranean* (S. Zupanovič, Yugoslavia)

Data on boats and personnel, and catches and their value, will be assembled, to make possible an assessment of the importance of Mediterranean fisheries.

C. *Biological Information*

Biological information for use in the preparation of more complete statistics will be assembled.

2. *Recommendations and General Resolutions*

A. The Council expressed a wish that FAO should establish a center for training statisticians or should sponsor courses on fisheries statistics, with at least two representatives from each Mediterranean country.

Prof. U. D'Ancona was re-elected Chairman of the GFCM for the ensuing year ; Mr. Ekrem Barlas, Director-General of the Meat and Fish Office, Ankara, Turkey, and Mr. A. Rodriguez-Carreño Mananzano, Dirección General de Pesca Marítima, Madrid, Spain, were elected vice-chairmen.

During the course of the Meeting, Morocco was admitted to membership thus bringing the total number of member countries to twelve — Egypt, France, Greece, Israel, Italy, Monaco, Morocco, Spain, Tunis, Turkey, the United Kingdom and Yugoslavia.

It will be seen that much of the Council's program of work is closely associated with the regular activities of the FAO Fisheries Division and, in fact, many of the activities are of a joint nature.

An example of the close association between the Council and FAO is the recommendation passed by the Economics and Statistics Committee that FAO organize a training center on fisheries statistics to be attended by fisheries economists from all the countries in the Mediterranean area.

FAO Regional Conference for Asia and the Far East

The Third FAO Regional Conference for Asia and the Far East was held in Bandung, Indonesia, from 8 to 19 October 1956. The Conference was attended by 86 delegates and advisors, representing 19 FAO Member Governments, and by observers from the Economic Commission for Asia and the Far East (ECAFE), the U.N. Technical Assistance Board (UNTAB), the World Health Organization (WHO), and the Holy See. Mr. J. Alan Tubb, Regional Fisheries Officer for Asia and the Far East, and Mr. C. Beever, fisheries economist, FAO, Rome, represented the FAO Fisheries Division.

Three items on the agenda were concerned exclusively with fisheries, and the extent and number of the contributions to the dis-

cussion of these items served to focus attention on the increasing importance which the fisheries industries are expected to assume in the food economy of the region.

The first item, " The Role of Government in Fishery Development, " was introduced as one of a select number of major policy questions of regional interest. In a background paper, attention was drawn to the problems of small government fisheries services, handicapped by severe shortages of funds and of trained personnel, in the execution of large scale, far-reaching programs of fisheries development involving considerable increases in fish production and consumption. During the discussion, delegates referred to current programs and to the wide range of fisheries activities promoted under these programs over the last few years. Delegates confirmed that, while their governments recognized very clearly the opportunities for expansion of marine and inland fisheries industries, the increasing range and variety of activities in different fields of fisheries development had imposed an increasingly heavy burden on the small number of trained staff available to the fisheries departments. References were made to the need for strong government services and especially for more facilities for the training of government workers in technical fields. The extreme dependence of fisheries on other sectors of the economy was also recognized and the corresponding importance of co-ordination of government services at all levels. There were also several references to the need for regional co-operation and to the importance of the endeavors of the Indo-Pacific Fisheries Council (IPFC). Accordingly, the Conference addressed the following resolutions to Member Governments of the region :

(*a*) *that efforts should be intensified to staff, equip and train the fisheries services in conformity with the wide range of activities involved in current fisheries development programs ;*

(*b*) *that consideration be given to the benefits to be derived from inter-departmental consultation and co-ordination at all levels in the conduct of fisheries programs, bearing in mind the extreme dependence of fisheries on other economic activities.*

The second item, " World Survey of Living Aquatic Resources, " referred to one of a group of activities on which FAO sought the guidance of the Conference.

The Organization referred to the importance of information on fisheries resources as a basis to programs for the exploitation of these resources, and to the work which had been initiated for the systematic compilation of such information. It referred to action being developed through the IPFC in this connection, and asked the Conference for further endorsement of this program.

During the discussion delegates referred to the research programs of their respective fisheries services and emphasized the

paucity of information concerning these resources even including those at present under exploitation. They expressed support for the idea of such a survey and their desire to co-operate in its promotion, especially through the machinery of the IPFC, and the Conference adopted the following resolution :

> *The Conference recommends that where possible Member Governments should advise FAO as to the areas and species which should receive priority attention in the conduct of its World Survey of Aquatic Resources and within the limits of the facilities available to them should support the program by supplying all available information on a comparable basis concerning the resources exploited by their respective fisheries industries or resulting from investigation by their research institutions.*

The third item, " Co-operatives as a Means of Fostering Fishery Development, " was one of a number concerning current FAO activities, for which the support and co-operation of the Conference was sought. In this connection, delegates referred to the growth of the co-operative movement in fisheries in recent years and the problems arising from the special characteristics of fish production and trade. Particular emphasis was laid on the firmly entrenched position of the middlemen and their restrictive influence on the level of fish supplies and consumption. At the same time it was recognized that the middlemen performed certain functions essential to the conduct of the fishing operations by virtue of their dual role of financier and merchant, and that it was extremely difficult for governments of fishermen's co-operative associations to supplant or compete without adequate funds and personnel with specialized training in commercial fisheries operations. Accordingly, the Conference expressed strong support for current FAO activities in this field and adopted the following resolution :

> (*a*) *that governments support the current FAO investigation of the respective functions of middlemen and fishery co-operatives in fish production and trade in some countries within the region and consider possibilities for extending the survey to other fishing centers in Asia and the Far East* ;
>
> (*b*) *that governments should give special attention to the critical need for trained fishery co-operative leaders and should endeavor to take advantage of facilities to be provided at the FAO/ETAP Training Center in Fisheries Co-operatives and Administration, proposed to be held in Australia in* 1957 (*see* pp. 58-59).

A remarkable feature of this Conference, of which the agenda covered a very broad field of current developments in agriculture, fisheries, forestry and nutrition, was the relatively large proportion of time devoted to the discussion of fisheries items. This must be taken as signifying not only the widespread interest of governments

in the possibilities for increased food production from the fisheries, but also the steady accumulation of experience acquired by governments in the construction and execution of their own fisheries development programs during recent years.

In the case of Ceylon, India, Indonesia and the Philippines, the delegations included fisheries representatives, but other delegations also contributed extensively to the discussions, indicating the attention devoted to this subject when governmental briefs were prepared. It was generally agreed by observers that this was a highly successful meeting of which the resultant recommendations offer most valuable, practical guidance to FAO in drawing up a realistic program of work adapted to the outstanding needs of the region. The excellent arrangements made by the Indonesian Government are also worthy of record inasmuch as they contributed so much to the smooth and efficient conduct of the Conference.

Biology Branch

The Biology Branch has continued its work developing bibliographic services for fisheries biologists. A contribution was made to the 1950 volume of the *Bibliographia Oceanographica*, published in the last quarter of 1956. In addition, assistance was received from Dr. J.E. Holmstrom of UNESCO, a specialist in techniques of documentation and terminology, who spent a fortnight with the Branch examining and advising on its methods. Further progress was made in developing the special decimal classification for fisheries science and in preparing a glossary for this classification.

Mario Ruivo of the Instituto de Biologia Marítima, Cais do Sodré, Lisbon, Portugal, on behalf of the Branch, made a special study of biometrical methods for the measurement and observation of clupeoids (especially the *Sardina pilchardus*), as used in fisheries biology. The study, which was presented at the 4th Meeting of the GFCM (*see* pp. 43-48), is being distributed to clupeoid workers throughout the world.

John Gulland of the Fisheries Laboratory, Lowestoft, England, at the request of the Biology Branch, prepared a paper on sampling methods in fisheries biology. This will be published in a forthcoming issue of the *FAO Fisheries Bulletin.*

The Branch continued to develop its interest in maritime meteorology by sending Taivo Laevastu to participate in the Second Session of the Commission for Maritime Meteorology of the World Meteorological Organization, which took place in Hamburg, Western Germany, in October 1956. Considerable interest was shown in the fisheries aspects of maritime meteorology, and the Commission recommended the establishment of a working group whose terms of reference are to collect and collate additional information on the need for extended collaboration by WMO with international fisheries organizations and to make recommendations concerning the ways and means by which this collaboration should be devel-

oped ; the group is also investigating the possibilities of co-ordinating weather services for the needs of fishermen.

Mr. Laevastu also represented FAO at a meeting in Geneva, Switzerland, 29-30 November, of representatives from UNESCO, WMO and FAO, to discuss oceanic disposal of radio-active wastes.

Horacio Rosa Jnr. attended the meeting of the UNESCO International Advisory Committee on Marine Sciences. Lima, Peru, in October 1956, where he presented a statement on FAO's interest in the development of oceanographic research.

S.J. Holt attended the 44th Statutory Meeting of the International Council for the Exploration of the Sea (ICES), in Copenhagen, Denmark, in October 1956, and the special meetings on " Herring Races " and the " Southern North Sea Herring, " which preceded the Meeting. He discussed with various participants the methodological aspects of population dynamics and, with representatives of the Comparative Fishing Committee, discussed the arrangements for the joint ICNAF/ICES/FAO meeting, to take place in Lisbon, Portugal, in May 1957, to consider population dynamics and gear selectivity.

Mr. Holt is also preparing material for use at the Training Course on Population Dynamics, sponsored by the Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Lowestoft, England, to be held in Lowestoft during February/March 1957.

Considerable attention has been paid to the resources survey program. A paper on this work was submitted to the FAO Regional Conference for Asia and the Far East (*see* pp. 48-57). Papers on the resources of the Mediterranean and of the Caribbean were presented to the GFCM, and to the 9th Meeting of the Gulf and Caribbean Fisheries Institute in November 1956, respectively. Dr. G.L. Kesteven participated in a meeting of the IPFC Rastrelliger Sub-Committee, Penang, Malaya, in September 1956, where a review was made of present information on Rastrelliger, and proposals were put forward for the further development of national research programs on this group. These proposals relate to the compilation on the distribution and identity of Rastrelliger and to the initiation of special research on races and on the biology of these species.

H. Rosa Jnr. visited the Permanent Training Center on the Survey of Natural Resources of the Pan-American Institute of Geography and History, São Paulo, Brazil, where he gave a short series of lectures on the methods of investigating resources.

K.F.W. Tiews (Germany), took up a 12 months' Technical Assistance assignment as marine fisheries biologist in the Philippines, where he will train Philippine workers in fisheries biological research, using the tuna program as demonstration material.

Finn Devold (Norway) has gone as Technical Assistance expert in marine fisheries biology to Brazil, to continue the program initiated by William E. Ripley (U.S.A.). This work is concerned with establishing a program of research of the marine resources of Brazil and at this stage particular attention will be paid to the stocks

of sardines. Clifford L. Petersen (U.S.A.) has begun a Technical Assistance project in marine fisheries biology in Venezuela, assisting the Government in the initiation of a program to study the clupeoid resources in the Gulf of Cumana.

Martin Burkenroad (U.S.A.), continued his Technical Assistance assignment in Panama, where he has been assisting the Government in establishing a program to survey the shrimp stocks of Panamanian waters. An interim report on this project is ready.

Dr. Hermann Einarsson, marine fishery biologist and hydrographer at the Fishery Research Institute, Reykjavik, Iceland, has taken up a 12 months' Technical Assistance assignment in Turkey as marine fisheries biologist. He will advise the Government on the research in fisheries biology which should be carried out in a survey and appraisal of marine fisheries resources, and will assist in the planning and carrying out of field and laboratory work in implementation of the program. This is in continuation of the program started by Olav Aasen (Norway), who terminated a two-year Technical Assistance assignment in Turkey in June 1956.

For inland fisheries, perhaps the most interesting recent development has been the holdings of the FAO Inland Fisheries Meeting in Helsinki, Finland, reported in *FAO Fisheries Bulletin* IX (4) : 201-2. The Branch has been engaged on extending its contacts with inland fisheries workers, and it was for this purpose that William A. Dill (U.S.A.) participated at the Commission for Technical Co-operation South of the Sahara (CCTA) Meeting in Brazzaville, French Equatorial Africa, in July 1956, as reported in this *Bulletin*, IX (4) : 203-4. Mr. Dill also attended part of the 13th International Limnological Congress in Helsinki.

W.H. Schuster (Netherlands), who had a short-term appointment under the Technical Assistance Program, made a survey of inland fisheries in Nicaragua, and of the fisheries programs in Guatemala and Honduras. He has made recommendations for the continuation of the program of S.Y. Lin (China), in the last two countries, and proposals for work in Nicaragua. Technical Assistance programs have been continued by Dr. S.W. Ling (China) in Ceylon, where he has acted for some months as FAO country representative ; Dr. C.J.D. Brown (U.S.A.) in Paraguay ; Dr. W.C. Beckman (U.S.A.), in Syria ; and by Dr. H.J. Elster (Germany) in Egypt. A. van den Eelaart (Netherlands), has completed his two-year assignment to Iraq, where he advised and assisted the Government in a survey of inland waters and in the formulation of a program of inland fisheries management.

Technology Branch

During the last quarter of the year, the planning and preparation for the International Fishing Gear Congress 1957 have been intensified. The Government of the Federal Republic of Germany has declared its readiness to act as host for the Congress, which

will be held from 7 to 12 October 1957 in Hamburg. H. Kristjonsson, Chief, Fishing Gear Section, attended the meeting of the Comparative Fishing Committee (ICES) in Copenhagen, Denmark, from 6 to 18 October 1956, to discuss preparations for the Congress with the Committee which has expressed great interest in it. Dr. A. von Brandt, Director of the Net Research Institute of the German Federal Fisheries Research Institute, spent one month in Rome as FAO consultant to assist in the preparation of the Congress, particularly in approaching potential authors of contributions. Dr. J. Schärfe of the same Institute also spent one month in Rome as FAO consultant, contributing to the preparations for the Congress and assisting in co-operation with the Italian Ministry of the Merchant Marine in preliminary studies of the Mediterranean trawl net. Mr. Kristjonsson visited Japan, to interest gear technologists there in the Congress.

Mr. Kristjonsson also spent two weeks in Noumea, New Caledonia, where he acted as Associate Director of the South Pacific Fisheries Training Course which FAO is conducting for a period of 14 weeks, beginning 19 November 1956, under the Technical Assistance Program, in co-operation with the South Pacific Commission.

Upon Mr. Kristjonsson's return to Rome at the end of November, P.A. Lusyne (Belgium), on temporary loan from his FAO Technical Assistance assignment in India, took over as Associate Director for the remainder of the Course. The Course was designed to train junior fisheries officers of the member countries of the South Pacific Commission how to handle fisheries problems, with the main emphasis on the technological subjects including the design of small fishing boats, their construction and mechanization, the design, manufacture and operation of fishing gear, fish handling and processing, elementary navigation and seamanship, and including lectures on fisheries biology, elementary knowledge of the sea, fish culture and problems of fisheries management.

In connection with the Fishing Boat Section's regular work on the design of fisheries research vessels, J-O. Traung visited the Union of South Africa to advise the Division of Fisheries on their plans for three fisheries research vessels. On his return he stopped over in Nigeria, the Gold Coast, Dakar, French West Africa, and Lisbon, Portugal, to advise fisheries officials on problems of beach landing craft, small boat mechanization and research vessel design.

Luigi Farina (Italy) has returned from a short-term technical assignment in Syria, where he made a survey of marine fisheries, and advised the Government on improvements in gear, vessels and methods, especially with regard to trawling in deep water. This was in continuation of an assigment carried out at the beginning of the year.

Paul B. Ziener (Norway), naval architect, was at Headquarters during November, to prepare an interim report on his Technical Assistance assignment to India, where he had been stationed

since August 1953. While there, he worked on both coasts, mechanizing available boats and designing new boats for use by the local fishermen.

Carl G. Bjuke Sr. (Sweden) who, during the last three months of 1955, worked on a Technical Assistance assignment as senior fish harbor specialist for the Central Government of India, has returned to India to join his son, C. Ragnar Bjuke, who has been there on a Technical Assistance assignment for the past year as junior fish harbor specialist, primarily in the States of Bombay, Madras and Saurashtra. Mr. Bjuke Sr. will study the work and recommendations of his son, and together they will prepare an interim report to the Government.

Other Technical Assistance projects in gear technology continue in Brazil (coastal and Amazon regions), Chile, the Netherlands Antilles, Haiti, Turkey, Sudan, Saudi Arabia, India, Ceylon, and the Philippines.

To further the Fish Processing Section's work on problems of fish processing under semi-tropical and tropical conditions, the Chief, Dr. W.F. Hampton, visited the Sudan, Uganda, India, Ceylon and Thailand, to discuss current problems with fisheries officials and representatives from the industries, and to inspect the progress of work of present, and the conditions of work of future, Technical Assistance experts in the Sudan, India and Thailand. Other projects continue in Brazil and Ecuador.

Christian Eriksen (Denmark) returned to Headquarters in November on conclusion of his short-term Technical Assistance assignment in Jordan as fish processing technologist. While there, he dealt with problems connected with the cold storage plant at Aqaba, and advised the Government on the refrigerated transport service from Aqaba to Amman, and on cold storage and distribution facilities in Amman and elsewhere in the country.

In connection with the Branch work on practices in fish inspection and food and public laws affecting fisheries products, Dr. E. Hess, Chief, Technology Branch, participated at meetings of the ECE team of experts on Standardization of Salted Herring and Fresh Fish, and of the ECE Working Group on Standardization of Perishable Foodstuffs, Geneva, in September and October 1956 where, as rapporteur of the team of experts on fresh fish, he presented the general draft recommendations of the team for the standardization of fresh fish in European international trade.

Dr. Hess was invited to prepare a review entitled " Current Technological Problems in Fish Canning " (published in *FAO Fisheries Bulletin*, 1X(4) : 161-80), for presentation at the Third International Congress on Canned Foods, held in Rome in September, 1956. This Congress dealt mainly with current technological canning problems ; containers ; machinery and equipment ; sanitary problems ; bacteriological problems ; publicity problems and canned foods in nutrition. Of special interest to the fish canning industry also were papers presented by Prof. Dr. W. Ludorff,

Director, Institute for Fish Processing, Federal Fisheries Research Institute, Hamburg, Western Germany, on " By-Products of the Fish Canning Industries ; " H. Riemann, formerly of the Technology Laboratory, Ministry of Fisheries, Copenhagen, Denmark, on " Bacteriological Problems of Canned Fish ; " and Dr. R. Kreutzer of the Hamburg Institute for Fish Preservation on " Bacteriological Problems of Semi-Preserved Fish. " Other papers dealt with market studies, and methods of publicity. Dr. M. Autret, of the FAO Nutrition Division, spoke on the role of canned foods in the world-wide distribution of foods. Some 500 delegates from 24 countries took part in the meeting.

Dr. Hess was invited to present the paper " Current Technological Problems in Fish Canning " also at the closing session of the Third Course for Italian Sanitary Inspectors for Fish and Fisheries Products on 16 October in Pescara ; he also participated in the official opening of the new Fisheries Technology Research Laboratory in that city, the first of its kind in Italy.

A monograph entitled *Electrical Fishing*, prepared by Prof. P.F. Meyer-Waarden of the Institute for Coastal and Fresh-water Fisheries, Hamburg, Western Germany, to be published in the series of FAO Fisheries Studies, has been edited and translated into French and Spanish in the Branch.

The work of the Branch on the trilingual dictionary of technological terms used in the fishing industry has been intensified, and the draft of the first section covering the field of fish curing has been completed for review by outside referees.

Economics and Statistics Branch

Statistics

The *FAO Yearbook of Fishery Statistics 1954-55*, Volume V, was published and distributed to all Member Governments and subscribers. This new edition is devoted to fish production and fishingcraft statistics, bringing up-to-date through 1955 detailed tables published in Volume IV, Part 1. The 72 tables are arranged in 8 sections and provide summaries as well as detailed tables of catches and landings according to country, region, fishing areas, groups of species, individual species, main channels of disposition ; and of production of processed and preserved commodities, fishingcraft and various aspects of the whaling industry.

The tables reflect a considerable increase in the coverage of data in regard to catches and landings.

The earlier appearance of this volume is due to a change from letter press to a more rapid photo-offset process.

Statistical Methods and Services

(*a*) *Northwest Europe*

F.E. Popper, Chief, Economics and Statistics Branch, attended the 44th Meeting of ICES, where he discussed working procedures

to ensure the close collaboration between the Council and FAO on common problems in fisheries statistics, including the standardization of methods.

(*b*) *Mediterranean Region*

C. Beever, representing the Branch, attended the 4th Meeting of the General Fisheries Council for the Mediterranean (GFCM), in Istanbul, 17 to 22 September. The Council considered a paper prepared by S. Zupanovič on the current state of fisheries statistics in certain Mediterranean countries, and unanimously adopted a resolution calling on FAO to conduct a training center in fisheries statistics for the benefit of member countries.

(*c*) *Egypt*

K.V.R. Sastry (India), fishery statistician, has returned from a Technical Assistance assignment where, since March 1956, he has been advising and assisting the Egyptian Government to organize and improve its collection of fisheries statistics. He has successfully devised and demonstrated a system of sampling adapted to cover the whole of the marine fisheries, and has reorganized the collection of fisheries statistics based on the use of improved forms, more accurate weighing and computation and more adequate supervision. Unfortunately, Mr. Sastry's work was interrupted at a stage where his methods were also being applied to the lake and river fisheries of the country.

Institutions and Services

The first three of a series of monographs dealing with selected fisheries institutions and services are about to be published.

(*a*) *Governmental Services to the Sea Fish Industry of Great Britain.* This was prepared on FAO's behalf by Dr. F.M.G. Willson of the Royal Institute of Public Administration, London, and provides a practical account of the different services performed by the British Government in connection with the sea fish industry of Great Britain. The monograph is intended primarily for the benefit of fisheries administrators who may wish to profit from British experience in fisheries legislation, administration and development. However, the essential background information covering the growth of the British fisheries industries should prove of general interest.

(*b*) *Fishermen's Organizations and the Regulation of Fish Prices in Sweden.* This was prepared for FAO by Mr. Christian Hessle of the Royal Fisheries Board, and Mr. Sigmund Verständig of the Agricultural Marketing Board of Sweden. A summary of the monograph can be found in *FAO Fisheries Bulletin*, IX(3) : 130-43.

The study covers the origin and early development of the fish dealers and fish dealers' organizations, a detailed examination of the management and activities of the fishermen's professional

unions and the fishermen's trading associations, as well as the system of price regulation applied on the east, west and south coast fisheries.

(c) *The Marketing of Sea Fish in the Federal Republic of Germany.* This was prepared for FAO by Messrs. Klaus Heinrich Krohn and Arnold Alewell of the Department of Economic and Social Sciences of Hamburg University, and includes a general review of the German fisheries industries and a detailed examination of the structure of the trade and different marketing agencies, selling arrangements, price formation and various current measures to promote increased fish consumption and greater technical efficiency in the distribution system.

Fish Marketing

K. Harding (Canada), of the Prince Rupert Fishermen's Co-operative Society, completed the first part of a Technical Assistance assignment to India, where his duties were to advise and assist the Government in the improvement and expansion of fish distribution, with special reference to co-operative marketing arrangements. His associate on this assigment, F. Barlind (Sweden), began his duties in October and since then has been working on the improvement of fish marketing organization and arrangements in the States of Bombay and Mysore.

Two fish marketing specialists on Technical Assistance assignments, D. Quiroga-Rios (Spain) and J. Fridthjof (Denmark), are also working in Ecuador and Brazil, respectively. An FAO Technical Assistance Fellow from Ecuador has been studying commercial organization and methods in fish production and marketing in Spain and Portugal. A Fellow from Turkey is also training in fish marketing organization and management in the Netherlands, Belgium and France.

F.E. Popper visited Uganda in November to make preparations for the implementation of the request by the Government of Uganda for the assignment of a fisheries economist to advise on developments in the marketing of fish from the Uganda lakes, particularly in the dried form. Mr. Popper also visited Tanganyika, Kenya and the Belgian Congo, to familiarize himself with the marketing arrangements for imported fish products, especially from Uganda.

Training Center in Fisheries Co-operatives and Administration

The Australian Government has formally invited FAO to conduct, in Australia, a training center in fisheries co-operatives and administration for the benefit of countries in the Indo-Pacific region, to begin in December 1957. Approval of the U.N. Technical Assistance Committee was obtained in December 1956. The syllabus will cover the following subjects : objectives of co-operatives ; problems of organization ; role of government, constitution and

management ; organization and methods ; procurement of supplies ; marketing ; credits for members ; organization of thrift ; welfare ; education ; miscellaneous. The course will comprise lectures, seminars and practical demonstrations at selected Australian fishing centers.

Economics

International Economics Association - Round Table on Fisheries Economics. In connection with its first Congress in Rome, the International Economics Association conducted a Round Table on Fisheries Economics at FAO Headquarters from 13 to 19 September 1956. Eighteen economists from Canada, Hong Kong, Iceland, Netherlands, Norway, Sweden, the United Kingdom and the United States of America attended the Meeting, which was organized at the suggestion, and with the help of, FAO. The following papers were discussed :

" Optimal Utilization and the Control of Fisheries "
" Obstacles to Agreement on Control in the Fishing Industry "
" Port Markets "
" A Note on Costs in Fisheries "
" The Marketing of Fisheries Products in the United States "
" Fishermen's Remuneration "
" Fish Marketing in Iceland with Special Reference to Foreign Trade "
" The Control of North Sea Fisheries "
" Special Problems of Fisheries in Poor Countries "
" The Interest of Fisheries Biologists in the Contribution to be made by Economists to Fisheries Science "

A report of the Meeting is now being prepared by the Association and this will shortly be available for distribution in conjunction with the technical papers contributed.

Survey of the Functions of Middlemen and Co-operatives in Fish Production and Marketing in the Far East and Southeast Asia. Arrangements were completed for the conduct of the first part of the survey which is now being undertaken by the Universities of Bombay, Hong Kong and Malaya. The survey is an attempt to throw some light on the very difficult marketing situation which persists in many parts of the Indo-Pacific region. Many governments, in their attempts to improve the efficiency of fish utilization and distribution in the interests of heavier production, have encountered serious obstacles arising from the restrictive effect of the firmly entrenched middlemen system and from the inexperience of co-operatives intended to supplant it. Mr. Edward Szczepanik, lecturer in economics of the University of Hong Kong, has been engaged as an FAO consultant to co-ordinate these studies. During the course of a journey to Rome to attend the Congress and a Round Table on Fisheries Economics of the International Economic Association, he had consultations with the universities concerned

and with FAO, as a result of which a plan of investigation was agreed covering the following main subjects : finance ; landing facilities ; technical progress ; insurance ; transport ; storage ; processing ; wholesale and retail marketing ; sales promotion ; market research ; problems of price stabilization ; import export trade ; co-ordination with other economic development, and fishermen's welfare. Mr. Szczepanik also discussed the plan with interested persons in Ceylon and Calcutta, with a view to an eventual extension of the project. These studies are being financed locally but in the case of Bombay, the Rockefeller Foundation has generously approved a special grant of up to 16,000 rupees to enable the university to undertake this project.

FAO Regional Conference for Asia and the Far East

C. Beever attended the Third FAO Regional Conference for Asia and the Far East in Bandung, Indonesia (*see* pp. 48-51), 8 to 19 October, and participated in the discussion of the fish items on the agenda.

State of Food and Agriculture

The Director-General's *Report on the State of Food and Agriculture 1956*, submitted to the FAO Council and Conference in September, 1956, contained a special chapter on " World Fisheries : General Trends and Outlook with Examples from Selected Countries. " Off-prints of this chapter are available.

Economic Surveys

The following Technical Assistance assignments were undertaken during the last three months of the year in response to requests from the respective governments.

(*a*) *Argentina*

J. d'Alarçāo, FAO Fisheries Economist, completed a Technical Assistance assignment in Argentina where, as a participant in the joint FAO/ECLA Mission, he conducted a survey of the fisheries.

(*b*) *Libya*

F.L. Bourgois (France), completed an eight months' assignment to Libya, where he made a survey of local fishing industries and recommended measures for their development.

Fisheries specialists on Technical Assistance assignments have also been conducting similar surveys in Tunisia, the Lebanon, and territories of the Caribbean Commission.

Book Note

Berdegué, J. *Peces de importancia comercial en la Costa Nor-Occidental de Mexico* [Fishes of Commercial Importance of the Northwest Coast of Mexico] Secretaria de Marina, Dirección General de Pesca e Industrial Conexas, Mexico City, Mexico, D.F. 1956. In Spanish.

This work was originally issued as a thesis (Mexico, 1954), when the author obtained his doctorate.

The chapters cover : I. Introduction, explaining the motives behind the study, and the criteria which determine a species of commercial importance. II. Illustrated keys for the identification of the different species described. III. A list of synonyms of common and scientific names. IV. A taxonomic description of each species, relationship, common name(s), distribution and commercial importance. In most cases the description is accompanied by a photograph, and by statistical tables showing catch for the period 1949-53. V, VI and VII. Summary in Spanish, bibliography and indexes.

Since *Peces marinos de la costa mexicana del Pacífico*, by Kumadat and Himayay, appeared in 1940, there has been no other publication of importance on the species and economic potential of this section of the Mexican coast. Berdegué's study, which follows very cosely Rodel's "Common Ocean Fishes of the Californian Coast," *Fish Bulletin* 91, California Department of Fish and Game, 1953, can be used as a reference work by all those directly or indirectly interested in the ichthyological fauna of the northwest coast of Mexico.

Revised Calendar of Meetings, etc.

March-December 1957

February 11 to March 9	UNESCO Regional Training Course in Marine Taxonomy and Planktology	Nhatrang (Viet-Nam)
March 4	Conference in Biophysical Research	Columbus, U.S.A.
" 20	Baltic Hydrographic Meeting	Helsinki
" 31	Inter-Island Marine Biological Conference	Porto Rico
April 2	OEEC Working Party (Fish)	Paris
" 8	Symposium on the Microbiology of Meat and Fish Curing Brines	Cambridge, U.K.
" 10	International Consultative Committee on Research of the UNESCO Program of Natural Sciences	Stockholm
May 7	International Hydrographic Bureau - 7th Congress	Monte Carlo
" 13	Indo-Pacific Fisheries Council - 7th Session	Bandung
" 14	Permanent Commission of the International Fisheries Convention (1946)	London
" 20	International Commission for the Northwest Atlantic Fisheries (ICNAF) - 7th Annual Meeting	Lisbon
" 20	Baltic and International Maritime Conference.	Paris
May	Caribbean Commission - 7th Session of the West Indian Conference	
May 27 to June 3	Workshop on Population Dynamics and the Selectivity of Fishing Gear (joint ICNAF/ICES/FAO)	Lisbon
June 1	South Pacific Commission - 8th Meeting of the Research Council	Noumea
" 1	Congress of the International Committee on Photobiology	Turin
" 24	International Whaling Commission - 9th Annual Meeting	London
June	International Internal Combustion Engine Congress	Zurich
June (for 6 months)	UNESCO Training Course in Marine Biology, Planktology, Ichthyology	Havana, Cuba
July 8	International Navigation Congress - 19th	London
July	Special Committee on Oceanic Research - 2nd Session	Cambridge, U.K. or Gothenburg, Sweden
August 8	International Statistical Institute - 30th Meeting	Stockholm
" 28	International Congress on Cell Biology - 9th Session	St. Andrew's (Scotland)
August	British Association for the Advancement of Science	Dublin
September 3	International Union of Geodesy and Geophysics - 11th General Assembly	Toronto
" 11	American Fisheries Society - 87th Annual Meeting	Las Vegas, U.S.A.

September 15	International Congress on Ship Hydrodynamics	Madrid
" 27	International Fisheries Trade Fair - 2nd	Copenhagen
" 27	Symposium on Techniques of Measuring Basic Marine Production (joint ICES/UNESCO/FAO)	Bergen
" 30	International Council for the Exploration of the Sea - 45th Meeting	Bergen
September	American Society of Limnology and Oceanography - Special Meeting	Woods Hole, U.S.A.
October 7	International Fishing Gear Congress (FAO)	Hamburg
" 20	Pan-Indian Ocean Science Congress - 3rd Session	Tananarive, Madagascar
" 21	International Fisheries Exhibition	Lowestoft, U.K.
November 2	FAO Conference - 9th Session	Rome
" 11	Gulf and Caribbean Fisheries Institute - 10th Annual Meeting	Miami Beach, U.S.A.
" 18	Pacific Science Congress - 9th Session International Advisory Committee on Marine Sciences (UNESCO) - 2nd Meeting	Bangkok
November	Caribbean Fisheries Seminar - 3rd	
December	Regional Conference on Sea Fisheries (CCTA)	Lobito, Angola

Training Centers

October 21 to December 14	Latin American Fish Processing Training Center	Lima, Peru
December 16 to January 25	Training Center on Fishery Co-operatives and Administration for the Indo-Pacific Region	Sydney and Adelaide, Australia

ED. NOTE. All dates are subject to revision.

STABILIMENTO TIPOGRAFICO FAUSTO FAILLI - ROMA